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NEW YORK, MARCH, 1889.

THE Department of Transportation, which is comparatively a new addition to the National Museum, under the charge of the Smithsonian Institute, in Washington, is making good progress in increasing its collection, under the energetic charge of Mr. Watkins. This Department is well worthy of attention, and its value could be largely increased should it receive the attention and support which it deserves from the railroad companies. There is doubtless a large amount of material scattered around the country, which would be of service in such a collection, but which is liable to be lost if not cared for, and any one knowing of the existence of such material, will be doing a public service by calling Mr. Watkins's attention to it.

BRIDGE engineers seem to have devoted themselves lately to the construction and designing of long spans, and projects for big bridges multiply. If they are all carried out, the Hudson, the Mississippi, and others of our great rivers will be crossed at points hitherto considered impracticable, and by spans of a length which not long ago was deemed impossible except with a suspension bridge. This is partly due to the continued improvement in material available for use in bridges, and partly of the successful results which have been attained recently in long-span bridges at various points.

THE agitation which has been begun by several of the local engineering societies in favor of improvement in highway bridges, has very much to recommend it. The methods which have prevailed to a great extent in letting the contracts for such structures are not to be commended, and the decision between different bidders too often depends upon a board of local commissioners, who are entirely ignorant of the first principles of bridge construction, and are apt to be governed by motives not above suspicion. Honest bridge-builders have been discouraged by the impossibility of competing with those who are not above adopting doubtful methods, and the result has been apparent in the construction of many bridges which are anything but a credit to their builders.

There may be some difference of opinion as to the results to be obtained by State inspection, which is proposed as a remedy, but at present it seems to be the only practicable way of getting at this evil, and the agitation in its favor must be considered as a step in the right direction. If it is to be carried out it might be extended to all highway bridges and crossings, including not only the larger and more important ones, but the small structures, which are usually designed and built by some local carpenter, and are not unfrequently examples of poor design and worse workmanship.

THE Illinois Central, which has always been considered one of the safest and most conservative of companies, has suffered, like nearly all Western roads, from the loss of business and reduction in rates resulting from the building of parallel lines and from excessive competition. For the first time in many years its stockholders are obliged to face a reduction in dividends, and the situation is explained in a report just issued by the Company, which is simply a repetition of these facts emphasized by the figures and details given.

MILITARY considerations are not generally taken into account in building a railroad in this country, the only line in America whose location was finally determined by such considerations being the Intercolonial in Canada. We do not, therefore, appreciate how much they have to do with railroad building in European countries, and this fact may explain many things which will appear singular to us in consulting a railroad map of France, Germany, or Austria, for instance. In nearly all European countries the railroad systems are under strict Government regulation, and their lines are laid out and built with special reference to their use in time of war. This necessarily involves the building of some lines which are hardly required for commercial purposes and which cannot be profitable. In Germany and Austria nearly all such lines existing are owned and operated by the Government, but in France there has recently been considerable complaint from the great companies because they have been obliged to bear the burden of building and the cost of maintaining branches which were considered necessary by the War Department, but which are altogether unprofitable commercially. They ask relief from the Government and will probably receive it.

THE City Railroad Company, which proposes to build an elevated railroad in New York, running through the blocks and using public property only at the street crossings, has begun proceedings, by applying to the Courts for the necessary authority to condemn and purchase property, which it needs for its line. It will doubtless meet with much legal opposition and the result is very doubtful. The plan for the road is not generally known, and has, perhaps, been regarded somewhat doubtfully by the public, which has not had an opportunity of becoming acquainted with the details.

THE question of coast defenses, which is now attracting much attention in Congress and elsewhere, is calling out active discussion both in this country and in Europe. For our own protection we are to have, in the near future, at

least two floating batteries and one or more boats armed with the new dynamite gun, all of which will be efficient, but will go a very little way toward the real settlement of the question.

In this connection it may be noted that there is a growing distrust, among those who have studied the subject, in the torpedo systems, in which so much popular confidence has been placed, and especially in the automatic or self-moving torpedo. There has been no opportunity of testing these to any extent in actual service, but such experiments as have been made seem to show that very little reliance can be placed upon them, owing to the difficulty of giving them proper direction and of exploding them at the right moment.

A substitute for the automobile torpedo, or, rather, an enlargement of the idea, is the submarine vessel of which the *Nordenfelt* torpedo boat is the most advanced type. Several of these have been tried abroad with apparent success, and bids have recently been received by our own Navy for a boat of the same class, one of which will probably be accepted. These vessels are necessarily small and their use is attended with considerable risk, but they have, at any rate, the advantage that they can be directed and worked with some degree of certainty.

The dynamite gun is to be made a feature of the land as well as of the sea defenses of our coast, a number having been ordered by the Secretary of War for use in the forts near New York and Boston.

THE sea tests of the gunboat *Yorktown*, the latest addition to the Navy, have been remarkably successful so far as reported, the vessel behaving excellently and showing a higher speed even than the contract called for. On the preliminary test she made 17.2 knots an hour, her engines developing 3,550 H.P. with forced draft, while in a four hours' run at sea, and under unfavorable conditions of wind and tide, she made an average of 15.9 knots an hour, proving herself not only a fast, but a very steady vessel of her size. The *Yorktown* belongs to a class of vessels which will probably be an exceedingly useful one in our Navy, and it is to be hoped that the other ships now under construction will make as good a showing.

THE course of the Navy Department in limiting the size of the guns furnished to the new cruisers now building, and in avoiding the construction of anything like the 100-ton or even 67-ton guns of the English and Italian Navies, is meeting with much commendation from naval engineers abroad, many of whom have been always opposed to the use of these enormous guns. In fact a reaction against them seems to be springing up even in England, where some elaborate arguments have recently been presented against arming a vessel with one or two huge guns, and where the greater usefulness of the light vessels carrying a larger number of smaller guns is finding many advocates.

THE second cast-steel gun made for the Navy Department has met with better success than the first, having passed through the preliminary tests successfully; however, it has still to undergo what is known as the endurance test. This gun was made of open-hearth steel, the first one which failed having been of Bessemer steel, but it is not yet by any means certain whether the failure of the Bessemer gun was due to the material or to defects of the casting. The tests of the second gun are shortly to be resumed and will be exhaustive in their nature.

This is a question of considerable importance, not only on account of the lower cost of cast guns, but also on account of the rapidity with which they can be made, which would be a matter of very great importance under certain contingencies. It is not impossible that the final result may be a compromise between the cast and the built-up guns, the nature of which may be readily suggested.

HIGHWAY grade crossings are the subject of an elaborate report made to the Massachusetts Legislature, by a special commission appointed last year. This report states that there are in the State 2,280 grade crossings, while there are only 748 crossings at which the track and road grades are separated either by an overhead or an under crossing. Of the grade crossings not less than 1,393 are unprotected by gates, flags, or other signals. In the 10 years ending with December last, 75 grade crossings were abolished, but during the same period 155 new ones were made, so that the number has been actually increased. How much delay and how much risk of accident is caused by this great number of level crossings in a populous State like Massachusetts cannot easily be imagined. The Commission recommends, as the first step toward a reform, an absolute prohibition of any new crossings of railroads and highways at grade. As to the abolition of the existing ones, it considers that a very difficult question is presented, on account of the great expense required, while at the same time it is to be considered that the cost will grow with every year of postponement. A general estimate of the expense of doing away with these crossings, were the work to be done at once, puts the total cost at $48,131,000, an amount which, it will be readily seen, neither the railroads nor the towns are able to meet now.

The plan recommended is a gradual separation of the grades, say 5 per cent. of the number to be finished in each year, and it is further recommended that the cost be divided between the railroads and the towns. It is admitted, however, that it would be entirely impossible to pass any general law regulating the division of cost, and that each case must be judged on its merits by some special tribunal to be provided for by the Legislature.

COMPOUND LOCOMOTIVES.

THE arrival in this country of the Webb compound locomotive, which the Pennsylvania Railroad Company ordered about a year ago, will naturally lead railroad engineers to consider the merits of the compound system, which has now been thoroughly tested on English and Continental railroads. It has been pointed out by some one that an unwillingness to profit by the experience of foreigners is a natural defect of the American character. This fault the officers of the Pennsylvania Railroad have avoided, in the present instance, at least. The advantages of the compound system, as applied to locomotives, have been definitely promulgated by thoroughly competent engineers like Mr. Webb, of the London & Northwestern Railway, Mr. Worsdell, of the Northeastern Railway, Mr. Von Borries and Mr. Mallet, on the Continent, who have all had ample experience in the use of such engines to enable them to form correct opinions regarding their advantages. The officers of the Pennsylvania Railroad, therefore, assumed the position that, if there was any merit in the compound system,

engineers of the ability of those named, who had given much time and thought to its introduction, and who have had more experience in its use than any other persons, would necessarily know more about it than any one else could. The Pennsylvanians therefore determined to test the system, and in doing so to avail themselves of the experience of those who had gone before them and avoid their mistakes and profit by their success. A locomotive was therefore ordered to be built in England under Mr. Webb's directions, with few or no restrictions, leaving the responsibility for the success or failure of the engine entirely with him. A mechanic has come over with the machine, to erect it, and a locomotive runner and fireman have been sent to run it. In other words, the Pennsylvania Railroad officers have said to Mr. Webb, "We want to profit by your experience; send us one of your engines and show us what it can do"; which seems a very much wiser course to pursue than the pretentious policy—altogether too common—of assuming that a person without investigation or study or experience knows more of a subject than intelligent people do who have given years of time and thought to learning all that can be known about it.

It would not be necessary to go very far to find illustrations of this error. Some years ago, for example, the traffic of this country demanded a more perfect system of signals on our railroads. Under those circumstances it might be supposed that, if anywhere on the face of the globe, a similar condition of things existed, and years of time, study, and experience had been devoted to supplying the demand, that railroad managers and engineers would eagerly avail themselves of the results of that study and experience. Instead of doing this there was a period when it seemed as though every ingenious railroad engineer in the country was devoting himself to the evolution, out of his inner consciousness—without any knowledge or experience of the subject—of a system of railroad signals. When managers or engineers were without ingenuity themselves, they called in the aid of the cranks, and the yards of the railroads of the land for a time fairly blossomed with signals of every conceivable form and shape. In the absence of any other source of illumination a pack of cards seemed to be the first source of inspiration, and hearts and diamonds and the ace of spades did duty as signals on various roads. In New England huge banjo-shaped signals were erected on several lines, until it seemed as though they were devoted to advertising some company of negro minstrels. If the signal evolutionists had simply consulted a little book, "Railroad Appliances," published about this time, they would have found the following statement: "About 1841 the signal known as the Semaphore signal was introduced by Mr. C. H. Gregory, and has been found so superior to all other types, that it is rapidly superseding all the other signals, and before long it will probably be the only daylight fixed signal used in this country" (England). The prophetic part of this seems likely to apply here as well as to Great Britain, as the diamonds, hearts, spades, and banjos are falling like leaves in autumn, and the Semaphore signal is extending its warning arm from one end of the land to the other. The same process was gone through with reference to systems of interlocking and block signals. A great variety of these were tried and much money wasted, while at the same time entirely successful and practical systems were in use in Europe and were adopted later here, after a good many imperfect plans had failed. Since then American genius has been exercised on the European systems, and they have been improved and adapted to our wants and requirements. The moral of this is that when any persons know more of a subject than we do, it is wisdom to profit by their knowledge. Of course if they do not know more than we, there is nothing to be gained from them. No American would go to Europe for information about building grain elevators, threshing-machines, saw-mills, or sinking oil and gas wells, but it is, perhaps, not disloyal to admit that there are some subjects about which they have had more experience than we have; and that compound locomotives is one of them.

After the Pennsylvania-Webb engine has shown what it can do, there will be a chance for American locomotive engineers to improve on it, and it will be very surprising if it does not go through an evolutionary process which will adapt it much better to its new environment on this side of the Atlantic. But even if the Webb engine does all that is claimed for it, the adoption of the compound system may still be an open question. In a paper recently read before the Institute of Civil Engineers it is claimed that it effects a saving of about 15 per cent. in the consumption of fuel. On the Pennsylvania Railroad, including the New Jersey and the Philadelphia & Erie roads, the fuel consumed by locomotives costs annually nearly $3,000,000; 15 per cent. on this would be $450,000. It would seem as though considerable outlay could be profitably made to effect such a saving. In this, as in many other cases, it is not safe to come to conclusions quickly. There can be no doubt that by the use of feed-water heaters a saving of from 10 to 12 per cent. of the fuel can be effected. This can be proved theoretically and has been demonstrated practically. Nevertheless, feed-water heaters have been tried times without number, and have always been abandoned, unless their use is continued under the stimulus of the inventor's "influence." Now, what is the reason for this? It is due, apparently, to the fact that the use and maintenance of feed-water heaters is attended with some extra care and expense; but perhaps more because feed-water heaters lessen the number of days and miles of service which locomotives will render annually. There are periods on nearly all roads, when the service of every locomotive which the company owns is urgently needed, and when the loss of such service means a serious pecuniary loss. Every appliance or additional part applied to a locomotive increases the liability of its being disabled, and because feed-water heaters are liable to fail at such periods seems to be—more than any other cause—the reason why their use is abandoned. It seems not to be as generally recognized as it should be, that the loss of the service of a locomotive, when it is most needed, is a very serious and costly matter.

The writer of the paper already referred to says that the adoption of high pressure steam is attended with the following drawbacks: "The boiler and all steam joints must be more carefully made. Only the better kind of lubricants are admissible, such as are not decomposed at the higher temperatures of the steam. The gland packings must be constructed to withstand heat. The high-pressure cylinder is liable to corrosion. The large low-pressure cylinders are more cumbersome and have more cooling surface than small compact cylinders. A large quantity of water of condensation might be observed in the chimney, thrown from the blast pipe of the large low-pressure cylinder, making safety valves on this cylinder essential. The momentum of a piston, 26 in. or 30 in. in diameter,

together with that of the other reciprocating parts of the large engine, causes severe strains, which must be provided for." To these objections must be added the additional cost of compound engines, and the hypothetical one whether they are more troublesome to run and maintain than simple engines.

The cost of fuel per locomotive per year on the Pennsylvania system may be taken in round numbers at $2,000 ; 15 per cent. of this—the saving claimed for the compound system—is $300, a sum which it would be very easy to absorb in the maintenance of additional or more complex parts, or by the loss of service of the engine.

NEW PUBLICATIONS.

PREPARING FOR INDICATION : *Practical Hints ; the Result of Twenty-three Years' Experience with the Steam-Engine Indicator :* by Robert Grimshaw, M.E. New York ; Practical Publishing Company.

This is a small book containing practical directions for applying an indicator to different classes of engines. It is well illustrated, and will be of value to those without experience who want information with reference to the use of this important instrument. The directions relate chiefly to the methods of attaching indicators to cylinders, the arrangement of pipes, levers, etc., details which are sometimes puzzling to new beginners.

COMBUSTION IN LOCOMOTIVE FIRE-BOXES : BY ANGUS SINCLAIR. New York ; *National Car & Locomotive Builder.*

This is a small pamphlet of 21 pages, which contains an elementary explanation of the theory of combustion, with practical directions for firing a locomotive. It is written in a very simple and lucid style, admirably suited to the purpose for which it is intended, which is "to supply knowledge-seeking enginemen with information relating to the fundamental principles underlying the art of firing."

BULLETINS OF THE UNITED STATES GEOLOGICAL SURVEY : NUMBERS 40-47 INCLUSIVE. Washington ; Government Printing Office.

The present issue continues the admirable series of monographs issued from time to time by the United States Geological Survey on various topics connected with its work. The subjects of the present numbers are :

No. 40 : Changes in River Courses in Washington Territory due to Glaciation.

No. 41 : The Fossil Faunas of the Upper Devonian—the Genesee Section, New York.

No. 42 : Work done in the Division of Chemistry and Physics, mainly during the Fiscal Year 1885-86.

No. 43 : The Tertiary and Cretaceous Strata of the Tuscaloosa, Tombigbee and Alabama Rivers.

No. 44 : Bibliography of North American Geology for 1886.

No. 45 : Present condition of Knowledge of the Geology of Texas.

No. 46 : Nature and origin of Deposits of Phosphate of Lime.

No. 47 : Analyses of Waters of the Yellowstone Park, with an Account of the Methods of Analysis Employed.

It is impossible to review these monographs in detail, and it can only be said in a general way that the work which the Survey is doing is much increased in value to the scientific world by the issue, from time to time, of these notes of progress made and results obtained.

PLATE GIRDER CONSTRUCTION : BY ISAMI HIROI. New York ; published by the D. Van Nostrand Company (Van Nostrand's Science Series, No. 95 ; price, 50 cents).

The use of plate girders is becoming more general every day upon our railroads, for highway crossing bridges and for railroad bridges of less than 60 or 75-ft. span. When properly designed, nothing can be more economical or secure ; the majority are, however, faultily designed in regard to the most economical use of material, and some few in regard to actual safety.

As the Author states in the preface, this little book "presents in as simple a manner as possible a rational mode of designing plate girders." Without going exhaustively into the theory of stresses, it explains concisely the nature of web stresses, the graphical method of finding the maximum shear under any load, and rules for the proportioning of the web with the design and spacing of the stiffeners. Then follow the flange-stresses, and the proportioning of the flanges and plates, with clear and concise instructions upon the spacing of rivets and the making of all necessary splices and connections, together with rules for the lateral bracing.

There is just enough theory introduced to enable one to understand the course of reasoning followed in formulating the rules given.

Owing to the lack of books on this subject that are within the general reach of draftsmen and engineers, this work ought to find ready acceptance at their hands and prove a useful book for students of engineering.

REISE S. M. SCHIFFES "ALBATROSS" NACH SÜD-AMERIKA, DEM CAPLANDE UND WEST-AFRIKA, IN DEN JAHREN 1885-86. EDITED BY CAPTAIN JEROLIM VON BENKO. Pola, Austria ; issued under authority of the Ministry of War.

This is a very full account of a cruise made by the Austrian war-ship *Albatross* in the South Atlantic, and is one of a series of similar accounts issued under the charge of the Hydrographic Office of the Austrian Navy. It is not a mere journal or log of the ship's voyage, but contains much valuable information with regard to the countries visited, their government, commerce, etc., and facts of service to navigators.

It is accompanied by a large map showing the course followed by the *Albatross* on her cruise and the various ports at which she touched.

CHALLEN'S ENGINEERS' LOG-BOOK OF THE DAILY RUNS OF AN ENGINE FOR ONE YEAR. New York ; published by Howard Challen, 140 Nassau Street (price, 75 cents and $1).

This very convenient and almost indispensable companion for a stationary engineer is a book of convenient size for the pocket, with a page for each week in the year, a line being given for each day. It is ruled, with printed headings, columns being given for average pressure ;

hours run; revolutions; vacuum; piston speed; indicated H.P.; initial pressure; terminal pressure; temperature of hot well and heater; water used per H.P.; fuel burned; ashes; oil and waste used, and a blank column for any additional note which experience may suggest. A blank space is also left to note defects observed, repairs needed, and any other necessary matters.

With this book it is the work of only a few minutes each day for an engineer to keep a full record of all essential points relating to the working of his engine. How useful this is all careful engineers know, and no small part of its helpfulness lies in the ability to refer readily to the past record and compare the running of the engine at different periods and under different conditions.

DEVELOPMENT OF TRANSPORTATION SYSTEMS IN THE UNITED STATES: *Comprising a Comprehensive Description of the Leading Features of Advancement from the Colonial Era to the Present Time, in Water Channels, Roads, Turnpikes, Canals, Railways, Vessels, Vehicles, Cars and Locomotives; the Cost of Transportation at Various Periods and Places, by the Different Methods; the Financial, Engineering, Mechanical, Governmental and Popular Questions that have Arisen; and Notable Incidents in Railway History, Construction and Operation; with Illustrations of Hundreds of Typical Objects:* by J. L. Ringwalt, Editor of the *Railway World.* Philadelphia; published by the Author.

This long descriptive title, while it is a little inconvenient on account of its length, has the advantage of giving information of the general character of the book, which is a good-sized quarto volume of 398 pages, liberally illustrated with engravings—such as they are. As its title indicates, it has a historical character, but it can hardly be called a history, as apparently no exhaustive investigation or no attempt even has been made to write a complete history of any branch of railroad development. That task still remains for some patient plodder who has at least the one characteristic of genius—an infinite capacity for taking trouble.

The book before us consists of a mass of interesting material, which the author has collected together during some years of editorial work on the paper with which he is connected. To a railroad man it is as interesting as a novel—much more so than some novels. It has a sort of flavor that reminds the reader of Cooper's stories, and one reads on and on continually interested in the variety of subjects to which it relates.

It is divided into three general heads—Before Railways; Railway Infancy; Railway Youth, and Railway Manhood. A sort of gossipy sketch of the different methods of transportation which have been used on land, water, and rail is given with illustrations of beasts, boats, vehicles, and structures in various ways related to transportation. With so interesting a book before us it is hard to drive away the smile of satisfaction and assume a frown of condemnation. But how did the Author succeed in having such wretched drawings and engravings made for his book? In this day of art culture and improved processes of engraving, it would be difficult to know where to go to have equally bad illustrations made. If the Author made his own drawings, the knowledge of it will lead the reader to wonder how he could be so good an editor and so poor an artist, and to feel sure that in the latter calling he has missed his vocation. The book would be increased immensely in value if the illustrations were what they should be, and also if the source from which they were obtained was given. In such illustrations the investigator finds that there is often great lack of authenticity. Thus the engraving of Oliver Evans's *Orukter Amphibolis,* opposite page 24, differs materially from that opposite page 160; and that of the *John Bull* on the same page looks as though it had an attack of dropsy.

It is always an ungracious task to point out errors in a work of this kind, because a reviewer with any experience as a writer has a vivid consciousness of the many errors which the Author did not fall into, and the pains he must have taken to avoid them. For old acquaintance' sake, attention should be called to the fact that the name of Mr. Bollman, the inventor of the bridge which bears his name, was not "August," as given opposite page 208, but Wendel.

The book will interest nearly all who are concerned directly or indirectly with railroads, but it is to be hoped that in a future edition the author and publisher may see his way to giving new and better illustrations.

EXHIBIT OF THE NAVY DEPARTMENT AT THE CENTENNIAL EXPOSITION OF THE OHIO VALLEY AND CENTRAL STATES, CINCINNATI, OHIO, JULY 4–OCTOBER 27, 1888. Issued under authority of the Navy Department.

This catalogue, prepared by Lieutenant Richard Rush, the representative of the Navy Department at the Exposition, is something more than a mere catalogue of the articles shown, and gives an excellent and connected account of the exhibit, the object of which was to give, first, a representation of the work now in progress in the reconstruction of the Navy, both in ships and armament; and, second, a general view of the extent and importance of the scientific work accomplished by the Navy in time of peace.

The exhibit included contributions from the Bureau of Construction and Repair, the Bureau of Ordnance, the Bureau of Navigation, the Naval Observatory, and the Naval Academy.

OUTLINE OF PLANS (WITH ILLUSTRATIONS) FOR FURNISHING AN ABUNDANT SUPPLY OF WATER TO THE CITY OF NEW YORK FROM A SOURCE INDEPENDENT OF THE CROTON WATER-SHED, DELIVERED INTO THE LOWER PART OF THE CITY UNDER PRESSURE SUFFICIENT FOR DOMESTIC, SANITARY, COMMERCIAL AND MANUFACTURING PURPOSES AND FOR THE EXTINGUISHMENT OF FIRES: WITH LEGAL, ENGINEERING AND OTHER PAPERS. New York; John R. Bartlett and Associates.

This book is an elaborate presentation of the advantages claimed for the plan of drawing an additional water-supply for New York City from the water-shed of the Upper Passaic in New Jersey, instead of procuring the supply from the Croton River by increasing the storage capacity in the basin of that river. It contains a number of addresses made in favor of the plan; legal opinions as to the right to use New Jersey waters; estimates of cost and a full statement of the urgent necessity of an additional supply. There is also a report from the Consulting Engineers who examined the project—Messrs. Clemens Herschel, Alphonse Fteley, and Captain T. W. Symons.

The illustrations include maps of the Croton and the Passaic water-sheds; a profile of the proposed pipe-line for carrying the water to and under the Hudson River; photographic views of a number of points in that section of New Jersey from which it is proposed to draw the new supply, and sectional views of the Hudson River Tunnel.

The plan has certainly been well presented by its advocates, for it would not be easy to find anywhere so elaborate a statement of the merits of any engineering project. Perhaps more space might have been given to its engineering side, and less to the legal and economic aspects of the question; but probably the book is intended to reach those who will control the decision of the question and the appropriation of the money rather than the engineers who will have to plan the details and supervise the execution of the work.

THE WOODWARD ELECTRICAL COMPANY, MANUFACTURERS OF THE DETROIT STORAGE BATTERY: CATALOGUE AND DESCRIPTION. Detroit, Mich.; issued by the Company.

There is, we believe, a very active controversy now in progress among electricians as to the true value and place of the storage battery. Without pretending to judge or to decide the question, there can be no doubt that the storage battery will have a place of its own, as a convenient method of applying electrical power in many places where the dynamo cannot be used.

This pamphlet gives an account of the construction and management of a new form of storage battery, with some considerations on the general question of the use of such batteries and the purposes for which they will be found convenient. There are also some elementary Electrical Data, by Lieutenant F. B. Badt, which will be found convenient for reference by the general reader.

VICK'S FLORAL GUIDE FOR 1889. Rochester, N. Y.; published by James Vick, Seedsman.

The practise of beautifying the grounds adjoining railroad stations is growing very general on the lines in the older-settled States, and has much to commend it. Station agents and others who need advice can hardly find a better guide than this work, which is not by any means a mere catalogue of seeds, but contains much useful information for the gardener, whether professional or amateur.

ABOUT BOOKS AND PERIODICALS.

THE Railroad Mail Service is described in the March number of SCRIBNER'S MAGAZINE by Thomas L. James, Postmaster-General in Garfield's Cabinet. A graphic account of the evolution of mail-carrying in this country, from the days of the colonial carrier to the modern fast mail train, is given.

Among the new books in preparation by John Wiley & Sons are included Professor Thurston's *Manual of the Steam Engine*, which is intended as a companion to his *Manual of Steam Boilers*. Other books in the same department are Professor Peabody's *Notes on Thermo-Dynamics and Steam Engine Experiments*; *Kinematics, or Practical Mechanism*, a treatise on the transmission and modification of motion and the construction of mechanical movement, by Professor Charles W. MacCord, and *Steam Engine Design*, by Professor J. M. Witham.

Those for the use of civil engineers are a *Treatise on Masonry Construction*, by Ira O. Baker; a *Treatise on Hydraulics*, designed as a text-book for technical schools, by Professor Mansfield Merriman, and Ganguillet and Kutter's *Flow of Water in Rivers and Other Channels*, translated, revised, and extended by Rudolph Hering and J. C. Trautwine, Jr.

The first number of the JOURNAL of the American Society of Naval Engineers, for February, 1889, contains articles on Trials of a Steam Barge, by Chief Engineer B. F. Isherwood; Tests of the High Service Pumping Engines at Washington, by Past Assistant Engineer G. W. Baird; Problems in Propulsion, by Assistant Engineer W. D. Weaver; Coals of the Pacific Coast, by Past Assistant Engineer C. R. Roelker; Quadruple Expansion Engines, by Assistant Engineer F. C. Bieg; also several other articles of interest, and a number of short notes on Steam Trials, New Ships and other current naval matters. The new Society, we understand, has already a large membership, and has, we hope, a prosperous and useful career before it.

An article which is worth careful reading is that on Slow Burning Construction, by Edward Atkinson, in the CENTURY MAGAZINE for February. Mr. Atkinson is an authority on more than one point, and his conclusions on a matter which he has studied attentively, are of interest to manufacturers, railroad companies, and architects who have occasion to build, design, or use large structures for industrial purposes. Economy and a regard for human life alike require the adoption of systems of building which shall avert danger from fire; and that these considerations should be so generally disregarded in our factory buildings is not creditable.

An article of interest to engineers in the POPULAR SCIENCE MONTHLY for February, is that by Professor G. A. Daubree, on Underground Waters in Rock Transformations. It is a continuation of several others on points relating to Underground Waters by the same Author.

In the same number Political Control of Railroads is discussed by Appleton Morgan, from the standpoint of an extreme opponent of any form of control whatever. Mr. Morgan argues plausibly, though many readers will hardly be disposed to admit all the premises which he assumes, and it would not be difficult to find flaws in his reasoning. Nevertheless, the article should be read as a good statement of one side of a much-disputed question.

Dakota, more than any Western State—except, perhaps, Kansas—has made by the railroads, and the article on that Territory in HARPER'S MAGAZINE for February, emphasizes this fact. The article is descriptive—almost colloquial—rather than statistical, but gives figures enough to support its facts and to give the reader a fair idea of the present standing and condition of what is likely to be the next new State, or, more probably, two States.

BOOKS RECEIVED.

ON THE USE OF HEAVIER RAILS FOR SAFETY AND ECONOMY IN RAILWAY TRAFFIC: BY C. P. SANDBERG, C.E. London, England; published by the Institution of Civil Engineers. This is a paper read before the Institution by Mr. Sandberg, who is well known as a high authority on the subject.

AN INVESTIGATION OF THE CONSTRUCTION OF THE VARIOUS KINDS OF CUPOLAS THAT HAVE BEEN USED FOR THE MELTING

of Pig Iron: by M. A. Gouvy, Jr.; Translated by W. F. Durfee, Engineer. Philadelphia; reprinted from the *Journal* of the Franklin Institute.

Annual Report and Statements of the Chief of the Bureau of Statistics, Treasury Department, on the Foreign Commerce and Navigation, Immigration, and Tonnage of the United States for the Fiscal Year Ending June 30, 1888: William F. Switzler, Chief of Bureau. Washington; Government Printing Office.

Eleventh Annual Report of the Board of Railroad Commissioners of the State of Iowa, for the Year Ending June 30, 1888: Peter A. Dey, Spencer Smith, and Frank T. Campbell, Commissioners. Des Moines, Iowa; State Printers.

The Journal of the Iron & Steel Institute: 1888. London; published for the Institute by E. & F. N. Spon.

Professional Papers of the Corps of Royal Engineers: Edited by Major Francis J. Day, R.E. Volume XIII, 1887. Chatham, England; published by the Royal Engineers' Institute.

Report of the Proceedings of the Twenty-Second Annual Convention of the Master Car-Builders' Association, held at Alexandria Bay, N. Y., June 12, 13, and 14, 1888. New York; issued by the Association.

Condensers for Steam Engines: by J. H. Kinealy, St. Louis; reprinted from the *Journal* of the Association of Engineering Societies. This is a paper read by Mr. Kinealy before the Engineers' Club of St. Louis at its meeting in December last.

Universal Milling Machines: Catalogue. Philadelphia; issued by Pedrick & Ayer, 1625 Hamilton Street.

The Harris-Corliss Engine as Built by the W. A. Harris Steam-Engine Company: Catalogue and Description. Providence, R. I.; issued by the W. A. Harris Steam-Engine Company.

Some Recent Boiler Explosions, and Short Talks to Steam Users. Hartford, Conn.; issued by the Hartford Steam-Boiler Inspection & Insurance Company.

How to Keep Steam Boilers Free from Incrustation: Tri-Sodium Phosphate Water Purifier. Philadelphia; issued by the Keystone Chemical Company.

The Comparative Danger to Life of the Alternating and Continuous Electrical Currents: by Harold P. Brown, Electrical Engineer. New York; published by the Author.

FRENCH AND AMERICAN PRACTICE WITH EMERY WHEELS.

To the Editor of the Railroad and Engineering Journal:

The carefully illustrated article in the February number of the Journal, translated from the *Revue Generale des Chemins de Fer*, would lead a superficial reader to imagine that French science had been brought to bear upon the emery wheel in a way that contrasted strongly with loose methods elsewhere. French practice and principle, if the above article correctly represents them, are strikingly different from the best practice and principle in the United States.

The French journal practically takes the ground that the safety of an emery wheel is an entirely unknown quantity, and that mechanical devices are needed as a supplement. The best American principle is embodied in the following quotation which has been widely circulated for years: "We caution the public against any and all mechanical devices to prevent wheels from bursting. Any wheel which will not stand a surface speed of 5,500 ft. per minute, in actual use, and without mechanical reinforcements, is unfit to run. We also caution the public against the use of stone-center, iron-center, and open-center wheels."

The mechanical devices which have been tried in the hope of making emery wheels safer have generally resulted in making them more unsafe. Wheels have been surrounded with cast-iron and other metal shields, which have generally broken at some weak point. Extra large flanges have been used, and still the bursting wheel would escape from their clutches. In one case, not content with extra large flanges, the users bored from four to six holes through the wheel and fastened the flanges by iron bolts running through the wheel. It seems needless to say that some of the bolts were screwed much tighter than others, and that the tension was so unequal that the wheel burst almost at once, killing the workman.

The whole tendency of mechanical reinforcements is to create a false idea of safety, and to prevent users from finding out *what* wheels are safe or unsafe and *why* they are safe or unsafe.

Wheels may be unsafe because the matrix in which the emery is embedded, or the cement which binds it together, have too little cohesion. Such wheels are often described as rotten. A wheel of this kind, bursting, would not be likely to exhibit *radial* cracks or breaks (as in the French case), but would throw pieces off irregularly. We have seen many such wheels in which all outside of the flange flew off, while that inside was held fast. Wheels may be unsafe because of unequal tension. Wheels made by the process of vitrifaction, or by artificial stone processes, or by any process in which the hardening, setting, or chemical change proceeds from the outside to the center, are likely to be subject to great and unknown inequality of tension. If such wheels do not crack from this tension before use, yet the repeated heatings and coolings due to use cause expansion and contraction whose final effect may be to start a break.

Wheels may be unsafe because of imperfect chemical combination and continued disintegrating chemical action. A wheel was once patented whose strongest claim rested upon the use of a material for its mechanical effect only, while the material employed possessed chemical properties unthought of by the user, and worked the ruin of the wheel.

Wheels may be unsafe because they are too good conductors of heat. We have seen two wheels of different makes tested, in which one remained uninjured and comparatively cool after 45 minutes' hard work, while the other burst after four minutes' work of some severity, and was so hot that it could not be handled. Yet both of these wheels had stood successfully the high speed test. The superficial observer would on this account have rated one as safe as the other, while the experienced user would have predicted that the one which was the poorest conductor was the safest. Those makers who advertise that their wheels consist entirely of cutting properties—that is, that they are wholly mineral—advertise their danger by that claim.

The safe wheel, then, must be made with a cement or matrix of great cohesive power—it must be a poor conductor of heat, it must contain no permanently active chemical ingredients, and it must not be made by any baking, drying, vitrifying, or setting process which acts from the outside to the center, subjecting the mass to, and often leaving it under unequal tension.

Having such a wheel as this, why then should it break? Such wheels might break from purely mechanical defects. For instance, some wheels are molded under high heats and with heavy hydraulic pressure. The mass of which the wheel is composed is forced by such pressure around and against the central steel pin whose office it is to mold the mandrel hole. If this wheel is removed from the mold at a moderate heat, or in an hour or two of time after it is finished, it would probably be perfect. But if allowed to remain too long in the mold and get too cold the contraction or shrinkage of a large wheel upon a pin only 1½ in. in diameter is enough to start a crack in the wheel. Such crack would start at the mandrel hole, would not be perceptible to a careless observer, and could only be traced an inch or two in the strongest light. In some processes

the wheels have to be forced out of the molds by hydraulic pressure, and the pins pushed through the wheels in some way. Now, the emery wears the pins rapidly, and sometimes these pins, owing to such wear, are not of uniform diameter, and being forced through split the wheels just as wedges would.

To sum up this feature let us say that in the handling of the wheel after it has been molded, there are several chances for the most perfect wheels to receive vital but almost imperceptible injury.

Now, the best American practice is to submit *every* wheel to a high speed test. A testing machine is so mounted in a bomb-proof that the machine can be set in motion and stopped by a man outside, and the wheel run under such conditions that no injury can result. Every wheel is run at a surface speed of from two to three miles a minute, though the standard working speed is only one mile a minute. At these speeds wheels which have unseen cracks burst; and by this simple method of destroying in his own factory all imperfect wheels, the American maker —that is, the maker of first-class wheels—succeeds in sending out wheels which may practically be called safe and perfect. If the *Revue Generale des Chemins de Fer* states the French practice correctly, it is the exact opposite of the American; for that journal says that, "Generally, in order to avoid the injury which might be done at too great a speed, the stone is run on its trial only at the highest speed which is to be used in service."

According to the best American practice the method to obtain a safe wheel is to choose one of such a make as is free from certain obvious defects, and which has been subjected to such high speed tests as would destroy all wheels having unseen weaknesses and injuries.

Having thus procured a safe wheel, the question still remains whether such a wheel is likely to break, and, if so, why? We answer that the most perfect wheel is likely to be broken under improper conditions of use. Some such improper conditions are shown in the very devices illustrated by the French journal as a means of obtaining safety. Note, in the first place, that the wheel is an "*open-center*" wheel, and that "open-center" wheels were denounced in the American caution quoted in the beginning of this article. Open-center wheels necessitate either the filling up of the center by the user or the use of flanges similar to those shown in the French illustration. Flanges like these, adapted to the use of open-center wheels, and having the inwardly projecting shoulder on which to center the wheel, were originally patented in America in 1870. At that time there was a general impression that the price of emery wheels was extortionate, and a very erroneous idea that the material of a wheel was more costly than the labor used in making it. In order to cut prices and also to secure the sale of larger wheels, certain makers put upon the market at reduced prices wheels having open centers, stone or composition centers, and molded upon cast iron hubs. Seeing the danger of all such devices, the patentees of the flanges very speedily withdrew them from the market, discountenanced all devices of the kind, and steadily advocated the use of wheels with holes adapted to the diameter of the mandrel or shaft on which it revolves.

Two dangers are inseparably connected with the use of the flanges shown in the French illustration. The first is, that if the flanges are screwed together very hard, as is certain to be the case, they will be sprung, or forced in toward the center, and the inwardly projecting shoulders will be thrown out, their pressure being so exerted as to wedge the wheel apart and disrupt it. The second danger is that if the inwardly projecting circular rims or shoulders are of such diameter as to nicely fit the hole in the wheel, then the expansion of the flange in case of a hot bearing would be likely to burst the wheel. If the hole in the wheel is molded with great mechanical nicety, the tendency would be to fit the inwardly projecting rim to the hole in order that the rim might be used to center the wheel. In this case there would be almost perfect circular contact. On the other hand, if the hole was imperfectly molded or the rim imperfectly turned, there would probably be actual contact between wheel and rim at several opposing points. Now the wheel shown in French diagrams would weigh about 1,500 lbs., and the hole in it is about 12 in. in diameter. If the continued revolution of a wheel of this weight should cause the bearing to heat, that heat would be communicated to the flanges, and the irresistible expansion of 12 in. of cast iron inside of the wheel would tear it apart. As iron expands about 0.0012 in. in being raised from 32° to 212° F., this would make an expansion (for this range of temperature) of about 0.0144 in. for a 12-in. rim.

Thus far all that is done by the French system tends to create the very danger which it is supposed to prevent. But one feature remains—the "bi-conical" shape of wheel. This idea, like that of the flanges, is a very old one, but has not been adopted by the best makers in America, because it is considered as opposed to the best practice and to the principle laid down in caution already quoted. The French article tells of one case only where a wheel broke, with radial lines, and where the flanges held the pieces so they did not fly out, and suggests, very wisely, that it would be better to make the plates or flanges thicker and the conical form more pronounced. "They would then resist still more the radial force of the fragments of the stone, which was produced on the trial mentioned above, and which, if it had been more pronounced, would have caused the fragments to strike against the frame and to produce additional breakages which might have resulted in serious accidents."

Now, accidents are just what would happen if this bi-conical shape was trusted to; for, if the speed was too great or the wheel too weak, it would break the flanges, or tear out from between them, or else what was outside of the flanges would fly off.

According to the best American practice the only office of a flange *is to keep the wheel from turning on its mandrel*. The flange should have enough surface contact and be screwed tight enough to make the wheel revolve *with* (not *on*) the mandrel. The next, and a most important point, of the best American practice, is to have the hole in a wheel so accurately molded and *of such greater diameter* than the mandrel on which it is to run, that the greatest possible expansion of the mandrel will not create any internal or wedging pressure upon the wheel.

In common practice buyers ask for a wheel with a 1-in. hole, when they want a wheel to go on a 1-in. mandrel. The intelligent maker gives a wheel with a hole so much larger than 1 in. that the expansion of the mandrel cannot burst his wheel. The buyer uses the hole to center his wheel by, and of necessity does not get it centered, but runs it with one part higher than the other in such a way that only part of the wheel touches the metal being ground. The correct practice is to hang the wheel on its mandrel, screw up the flanges *slightly*, then turn, chalk and center the wheel as carefully as if it was a piece of work being put in the lathe, and then give the flanges their final tightening.

Briefly, the best American practice is to choose a wheel whose composition is such as to make it free from the defects already pointed out; to buy only of makers of established reputation and long experience; and to insist that every wheel should be submitted to the high-speed test before delivery. Such a wheel should have a hole of diameter suited to a steel mandrel of a strength adapted to the weight of the wheel. In other words, the hole should be *no larger than necessary*, but should have due allowance for possible expansion of the mandrel. Wheels should be mounted on heavy substantial machines, set on and fastened to stone or concrete foundations—the latter clause applying only to heavy wheels.

The safety lies in buying wheels of safe make after they have been submitted to such rigid tests that all poor ones are destroyed, and then mounting those wheels in the *simplest* manner.

Unfortunately, foreign buyers are loath to pay the higher prices which such wheels naturally cost, and too often take the terrible risk of buying cheap wheels in the hope that good luck or some new-fangled safety device will protect them from accident.

Of course *misuse* may cause accident even with the best of wheels, but misuse is not the subject of this article.

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HYDRAULIC CANAL LIFT.

(From *Le Genie Civil.*)

THE Canal of the Center in Belgium is so called from the coal basin, which it was built to serve; it unites the canal from Charleroi to Brussels with that from Mons to Condé, forming a new junction between the basins of the Meuse and the Escaut. It has been built to avoid the roundabout route heretofore followed by the boats which carry this coal and to furnish a new line for coal intended for Brussels and Antwerp.

The principal difficulties encountered in the construction of this very useful work resulted from the great difference of level which it was necessary to overcome, and which amounted altogether to 89.547 meters (294 ft.). The first part of the canal, about 7 kilometers in length, has a rapid fall, running through the valley of the little river Thiriau. The second section, 13 kilometers in length, has a much more gradual fall.

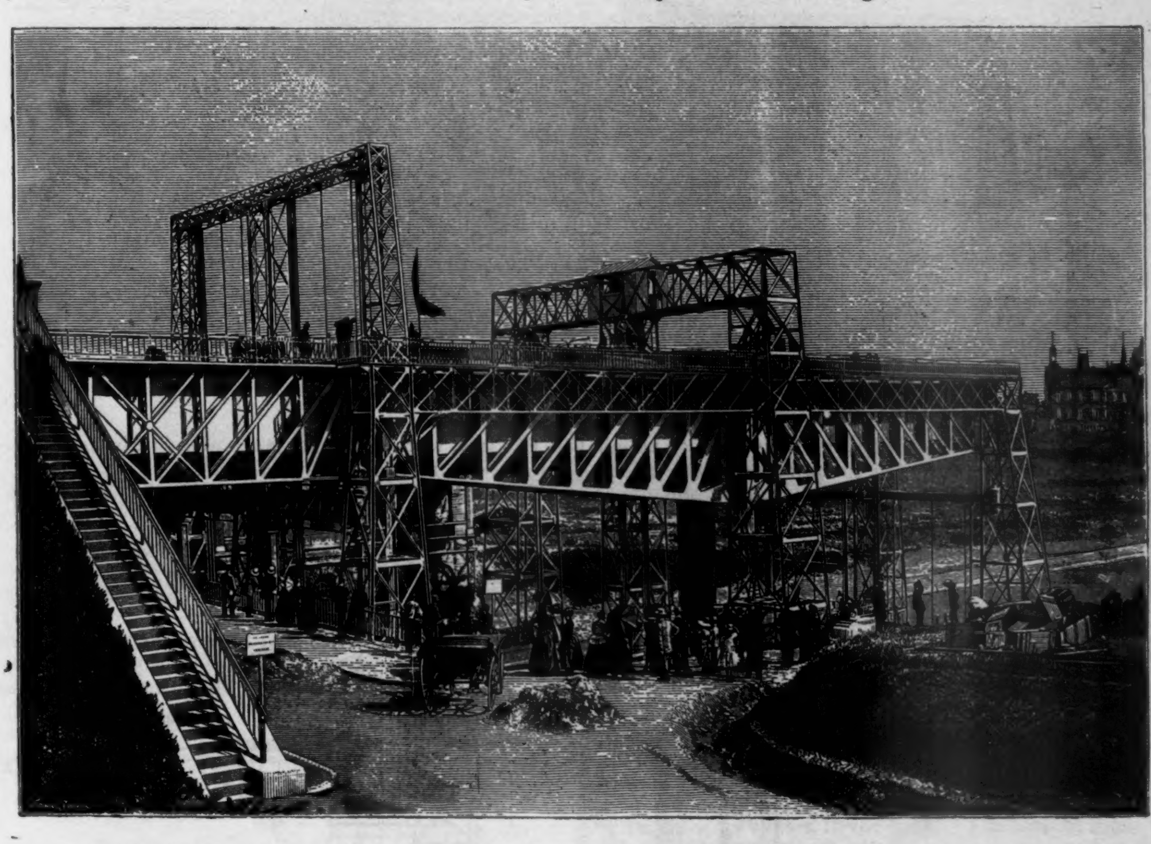
The plan adopted by the Government engineers included the establishment of four hydraulic lifts or locks on the system devised by Edwin Clarke. The first, built at Houdeng-Goegnies, overcomes a fall of 15.397 meters (50.5 ft.), the other three have a lift of 16.933 meters (55.5 ft.) each; the four lifts together thus overcome a difference of level of 66.196 meters (257.5 ft.). The remaining difference of level, which is in all 23.268 meters (77 ft.), will be obtained by six ordinary locks.

The hydraulic lift at Houdeng-Goegnies is shown in the accompanying illustrations, two of which are perspective views, while the other two show a side elevation and a section of the structure.

This lift or lock is composed of two movable basins or locks of iron, each supported by a single hydraulic press. The two presses are connected by a pipe, in which is placed a valve; when one of the lock-basins is at the level of the upper section of the canal, the other stands at that of the lower section, and communication is then opened between the two presses. The water, tending to establish a level between the two, forces one of the locks to descend, while the other ascends; when they arrive at the same level it is necessary, in order to complete the movement, to introduce into the descending lock an excess of weight equal to the weight of water continued in the other one. In the Houdeng-Goegnies lock or lift this excess is furnished by an addition of 0.300 meter to the depth of water, which represents a weight of 74 tons.

The chamber or lock, properly so called, and the metallic structure which supports it, with the gates which close its two ends, weigh 296 tons, and the piston of the hydraulic press weighs 80 tons; each press is capable of sustaining a total weight of 1,048 tons.

The piston of each of these hydraulic presses is of cast iron and is in three parts. The first part or head of the piston supports the lock chamber directly, and has the form of a plate 3.200 × 3.200 meters and 1.400 meters in height; the central portion, which is cylindrical, is formed of eight sections 2.130 meters in height and 0.075 meter in thickness, bolted together; the lower part is a spherical cap 1.000 meter in height.



The press, properly so called, has an interior diameter of 2.060 meters. Its base is a plate of cast iron 0.150 meter in thickness. The body of the press is composed of eight rings each 2.000 meters in height and 0.100 meter thick. Each section is re-enforced by steel rings 0.050 meter thick, shrunk on hot. The upper and the lower rings of each section have a square form and serve as flanges to unite the two adjoining sections. The top ring of the upper section is 1.599 meters in height, and is composed of three parts. The first part below is 1.167 meters in height and formed like the other section of the press. The middle portion, which is not hooped, is formed by a cylinder of cast iron joined to a hollow arch, also of cast iron, which is connected with an arch of the other press by a special system of tubes. In the cylindrical portion of the press leading to the arch there are a series of holes 0.050 meter in diameter. The third or top part of this section contains the stuffing box.

The water in these presses is at a pressure of 14 atmospheres, and all the parts have been calculated to resist a pressure of 80 atmospheres. Tests made on two sections of the cylindrical parts of the presses have given the following results: A section in cast iron 0.100 meter thick, and not hooped, was broken at 146¼ atmospheres, after having resisted a pressure of 152 atmospheres. A similar section

hooped with steel was tested up to a pressure of 265 atmospheres without breaking.

The locks are guided in their movement at six points, the four corners and at each side of the center. The guides at the angles are 3.425 meters in height, and those at the center, 7.692 meters. These guides bear against the trusses which carry the lock, which are very strongly braced.

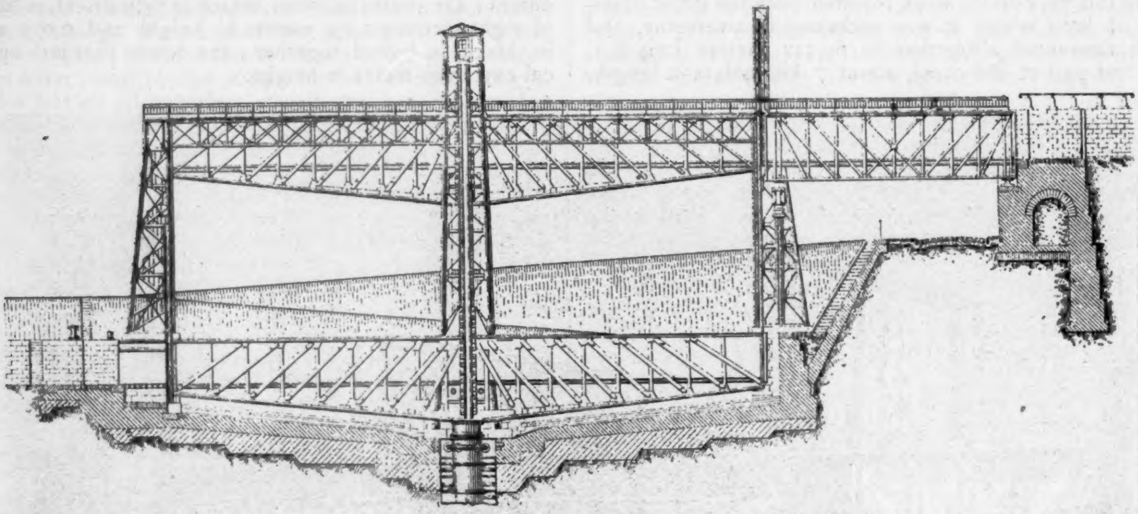
Above the lock the water of the canal is held back by a vertical wall in which is placed a gate for the passage of boats. The locks descend to the lower level in two large masonry basins made to receive them, as shown in the sectional view. Above and below the locks, when they come into place, are opposite two iron bridges or connections by which they can communicate with the water in the corresponding level of the canal, and the entrance to these bridges is closed by gates of the same type as those which close the ends of the lock. The joints between these connecting bridges and the canal are closed by means of angle-irons or packing-pieces faced with rubber, one side bearing against the lock and the other against the canal bridge.

These packing-pieces are raised and lowered, and the gates are opened by means of hydraulic apparatus; the boats are drawn into the lock by hydraulic capstans.

The water used to work the various hydraulic apparatus is furnished by two pairs of double-acting pumps, which pump water into an accumulator at a pressure of 14 atmospheres; each pair of pumps is worked by a horizontal turbine of the Girard system. Experience so far obtained with this lift shows that all operations necessary to pass two boats of 70 tons burden from the upper to the lower level, and *vice versa*, can be completed in 15 minutes. The actual movement of the locks, with the extra charge of water 0.300 meter in depth, lasts only 2 minutes 50 seconds. The amount of water drawn out of the upper level of the canal at each movement is 74 tons.

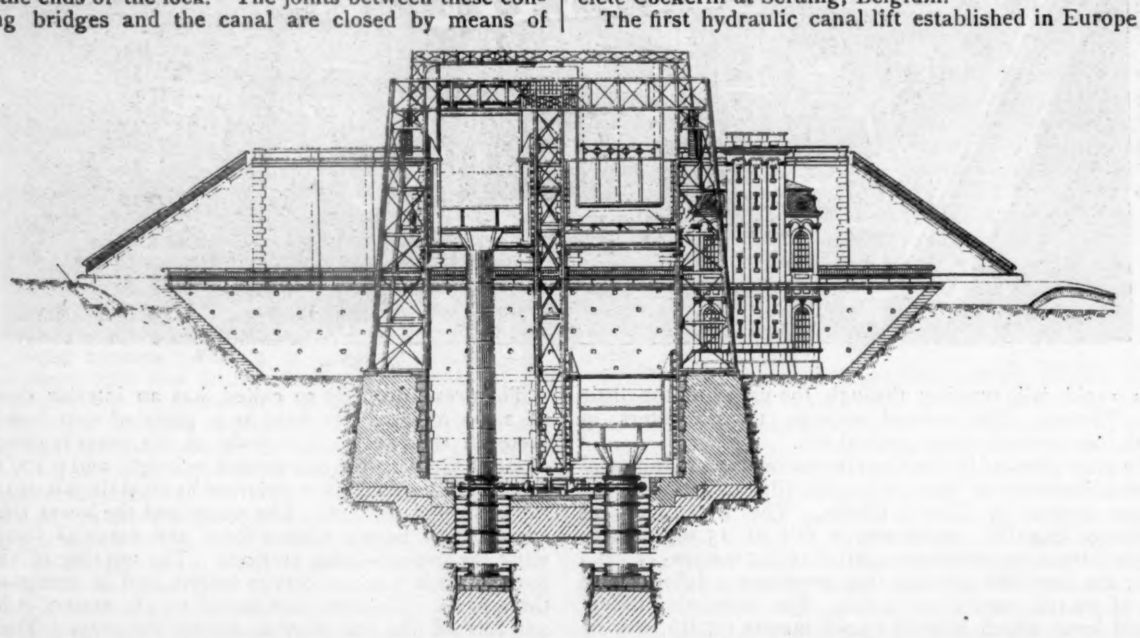
The total cost of this hydraulic lift was as follows:

Land	$ 2,250
Excavation, foundations and masonry	80,450
Iron and other metallic work, including all machinery	179,800
House for the men in charge of the lilt	5,400
Engineering and contingencies	13,900
Total	$281,800



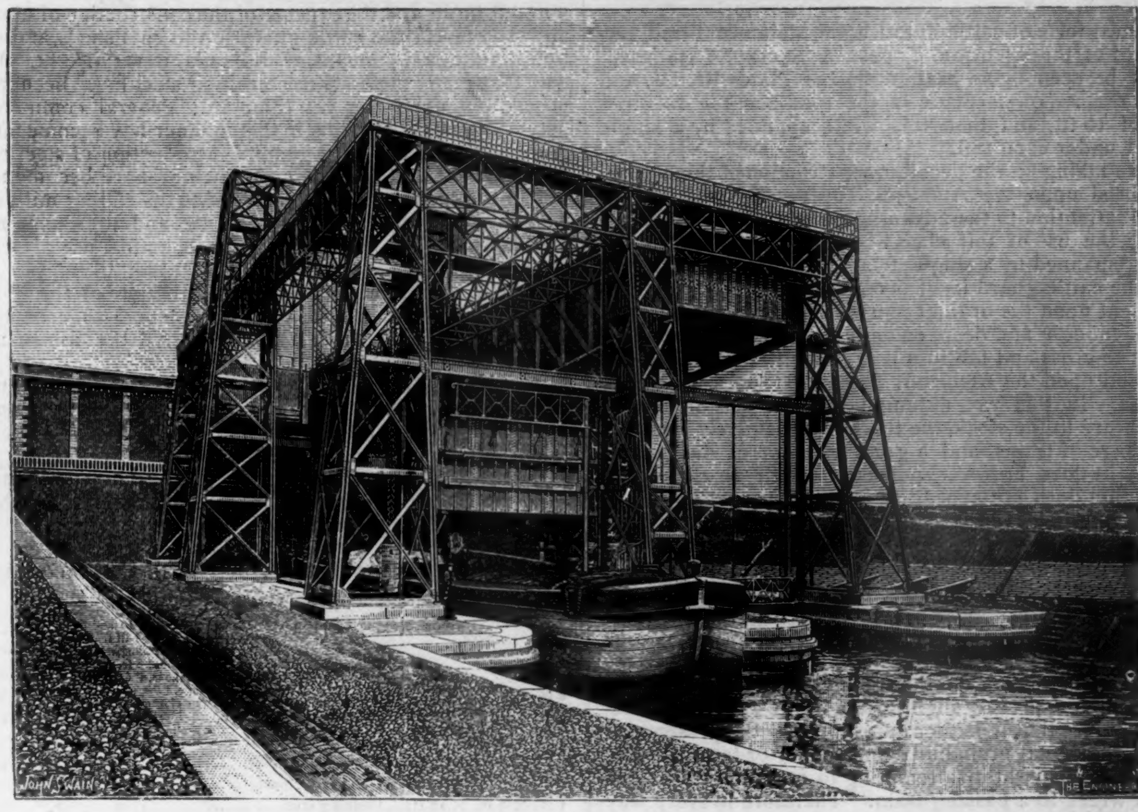
The iron work and machinery was furnished by the Societé Cockerill at Seraing, Belgium.

The first hydraulic canal lift established in Europe was designed by Mr. Edwin Clarke, and was built at Anderton, England, in order to overcome the difference in level of 15.350 meters (50⅓ ft.) existing between the Mersey and Trent Canal and the river Weaver. In this structure the movable locks or basins filled with water to their usual level weigh about 240 tons, and 15 tons of water gave the additional weight needed to complete the movement. The pistons are 0.910 meter in diameter, and the pressure of water in the hydraulic presses is 37 atmospheres. The length of the lock is 22.850 meters, and its width, 4.730 meters. This lock at Anderton commenced to work in July, 1875, and continued steadily in use until April, 1882, when the service was interrupted by the breakage of one of the



presses. It had been so successful, however, during seven years of continued use, that it was at once repaired and is now again in use.

In France a hydraulic lift for boats has been established on the Neufosse Canal, at Fontinelles, where it took the place of the series of five ordinary locks, which caused serious delay in navigation, as boats took nearly two hours to pass them. The hydraulic lift overcomes an ascent of 13.130 meters. The lock-basins are 40.500 meters long, 5.600 meters wide, and 2 meters in depth. The pistons of the presses are 17.200 meters in length, 2 meters in diameter, and 0.600 centimeters thick. The presses work under a pressure of 25 atmospheres, and the load carried by the piston is 800 tons.



THE USE OF WOOD IN RAILROAD STRUCTURES.

By Charles Davis Jameson, C. E.

(*Continued from page 71.*)

CHAPTER III.

CATTLE-GUARDS.

We come next to the question of Cattle-Guards. This question is, without doubt, one of the most vexatious on a small scale with which a railroad company has to deal. At every grade crossing, excepting those occurring in cities and villages, there is the necessity of constructing and maintaining two of these structures, one upon each side of the crossing. The object of cattle-guards is to prevent the passage of live-stock from the highways upon the right-of-way of the road, thus endangering their own lives and obstructing the traffic of the road.

Nearly every railroad company has its own peculiar manner of constructing its cattle-guards, scarcely any two using the same plans in every detail; but whatever plan may be used the object is the same, and that is simply to prevent the passage of live-stock without in any way obstructing the free passage of the trains, and any method of construction that shall accomplish this object at the slightest danger and expense to the road makes the best cattle-guard.

The most ordinary form of cattle-guard is that shown in Plate II. and is the standard guard used upon the St. Joseph & Iowa Railroad. By examining the plate it will be seen that an excavation 10 ft. wide is made across the road-bed, and four piles driven upon each side of this excavation, the top of these piles to be cut off 2 ft. 6 in. below the base of the rail. A 12 × 12 in. cap is placed upon the top of the piles, and then the opening spanned by means of two 12 × 12 in. stringers, 10 ft. long, placed 2 ft. 3 in. in the clear each side of the center of the track, thus giving each rail a full bearing upon the inside edge of the stringer. Upon the top of these stringers are placed ties 6 in. × 6 in. × 10 ft., spaced 14 in. from center to center. These ties are held to the longitudinal stringers by means of two drift-bolts to each tie, placed just outside the rails, as shown in the plan. The tops of these ties are beveled off to a depth of 2 in. on each side and at an angle of 45°, as shown in the drawing. This beveled part is placed up, and the full width of the tie is left under the rails and under the guard-rails, thus giving them sufficient bearing.

The guard-rails are also beveled on top, and are held to each cross tie by means of ¾-in. drift-bolts, as shown in the plan. This form of cattle-guard is more generally used throughout the United States than any other, and as far as preventing the passage of stock over it is concerned, it is very effective; but it possesses so many disadvantages and introduces such an increased element of danger to the running of trains that there appears to be scarcely any excuse for its ever being constructed. As will be seen, it is impossible for any stock to pass it, but if cattle step upon these cross ties, and it is a well-known fact that they very often will, they are sure to slip through and become caught in the guard in such a way that it is impossible for them to extricate themselves, thus presenting a strong probability that the next train that passes, unless the engineer is fortunate enough to see the obstruction in time to stop, will be derailed, and an accident of greater or less extent follow. There are innumerable examples of very costly wrecks—costly both from a financial standpoint and in the number of lives that were lost—having been caused simply by stock

getting caught in such cattle-guards as these. The bill of material is given below :

No. 5. Bill of Material for Cattle-guard.
St. Joseph & Iowa Railroad.

9 bridge-ties	6 in. × 6 in. × 10 ft.	270 ft. B. M.
2 guard-rails	6 in. × 4 in. × 10 ft	40 ft. B. M.
4 stringers	12 in. × 12 in. × 10 ft	480 ft. B. M.
8 piles, 12 in. diameter and of sufficient length.		
36 drift-bolts, ¾ in. diameter and 8 in. long.		
18 " " ¾ in. " " 12 in. "		

The next form of cattle-guard is the standard T-rail cattle-guard of the Atchison, Topeka & Santa Fé Railroad. As will be seen by an examination of Plates III, IV, and VI, an excavation is made in the road-bed the required width of 10 ft., and then this width spanned by a single stringer under each rail.

Before taking up the peculiar construction of this stringer, as used upon the Atchison, Topeka & Santa Fé, we will call attention to the advantages and disadvantages attending the use of this class of cattle-guard—that is, an opening spanned by a single stringer under each rail. As far as the cattle-guard itself is concerned, it is a great improvement upon the ordinary guard, provided the opening is wide enough and deep enough to allow any stock that attempt to cross and fall into it to fall entirely clear of the track, and upon the Atchison, Topeka & Santa Fé this is the case. In this way, although it may result in certain slight injury to the stock, the track is left entirely clear for the passage of trains, and a great element of danger removed. It does, however, possess in itself an element of danger that does not appear in the ordinary cattle-guard. The opening being spanned by means of a single stringer under each rail, if from any cause one of the trucks in a train happens to be derailed at the time the train passes one of these guards the truck will drop into the excavation, and thus wreck more or less of the train. This is an objection that applies to all openings spanned by single stringers, and is a very great one. The probability, however, of a truck being off the track at just this particular point is, of course, very slight, while in the ordinary cattle-guard the fact that it is there presupposes the presence of cattle, and a great probability that sooner or later some of them will get caught in attempting to cross the track, and cause a wreck to a passing train. Therefore in every way this T-rail cattle-guard, or any form where a single stringer is used to cross an opening, is much preferable to the ordinary form of tie cattle-guard.

Attention should be called to one distinctive feature of this cattle-guard, as used upon the Atchison, Topeka & Santa Fé Railroad, and that is the construction of the T-rail stringer by means of which the opening is spanned.

As will be seen by an examination of Plate V, each stringer is composed of three sections of rail. The size of the rail used corresponds with whatever rail happens to be used on that section of the road. Two sections of rail are placed base to base and riveted together in the shop, the bottom piece being 6 ft. long and the top piece 8 ft., so as to allow the stringer to have a bearing of 1 ft. upon each side of the guard. It has been found where open cattle-guards are used, that 6 ft. is sufficient to prevent the passage of any stock. The block or filler, as shown in the drawing, is made of cast iron, to correspond with the size of the rails used, and five blocks are used in each stringer. The chairs upon which the ends of the stringers rest are also made in the shops, so that the only thing necessary upon the road is the putting together of the different parts of which the stringer is composed—that is, putting the stringer upon the two upright rails, setting the rail upon which the train is to run upon the top of the filler-block, and then introducing the long bolt which holds the rails together, putting on the nut and the jam-nut, and setting the whole thing up. The rails upon which the train runs rest upon the tops of the filler-blocks, and are held in place by the heads of the stringer rails upon each side. When the long bolt is tightened up these running rails are held with great firmness. This stringer is practically indestructible, can be made out of old rails that have done their duty in the track, and thus utilize material which otherwise would be to a great extent valueless.

There is nothing new in this idea of crossing small openings by means of stringers made of old worn-out rails that will not do to run trains upon, but it has been developed to a greater extent upon the Atchison, Topeka & Santa Fé and the Mexican Central railroads, probably, than upon any other roads on this continent. Of course, one cause that has led to this is the great scarcity of wood upon many parts of these roads, but it is an economic question that would well repay our engineers to study more carefully and exhaustively, as the different uses to which these old rails can be economically put is almost without limit, and the expense of the construction of almost any structure, from cattle-guards up to coal sheds and station buildings, by means of old rails, is very slight. It is true that many methods for rerolling steel have been proposed, but none has yet come into general commercial use. The use of old rails in this manner has become much more desirable since the general introduction of steel rails from the fact that steel rails after having once become useless in the track cannot be returned to the rolling mills and rerolled as the old iron rails could be, and thus some new method must be found for the economical use of scrap steel rails.

Plate V shows in detail the construction of the T-rail stringer, with the ordinary 56-lbs. section, as used upon the Atchison, Topeka & Santa Fé. All the dimensions are put upon the plan.

Plate VI shows in detail the construction of the cattle-guard fences. This plan only shows the construction of the fence upon a fill, but from it can be readily seen the construction either in a cut or upon a level section.

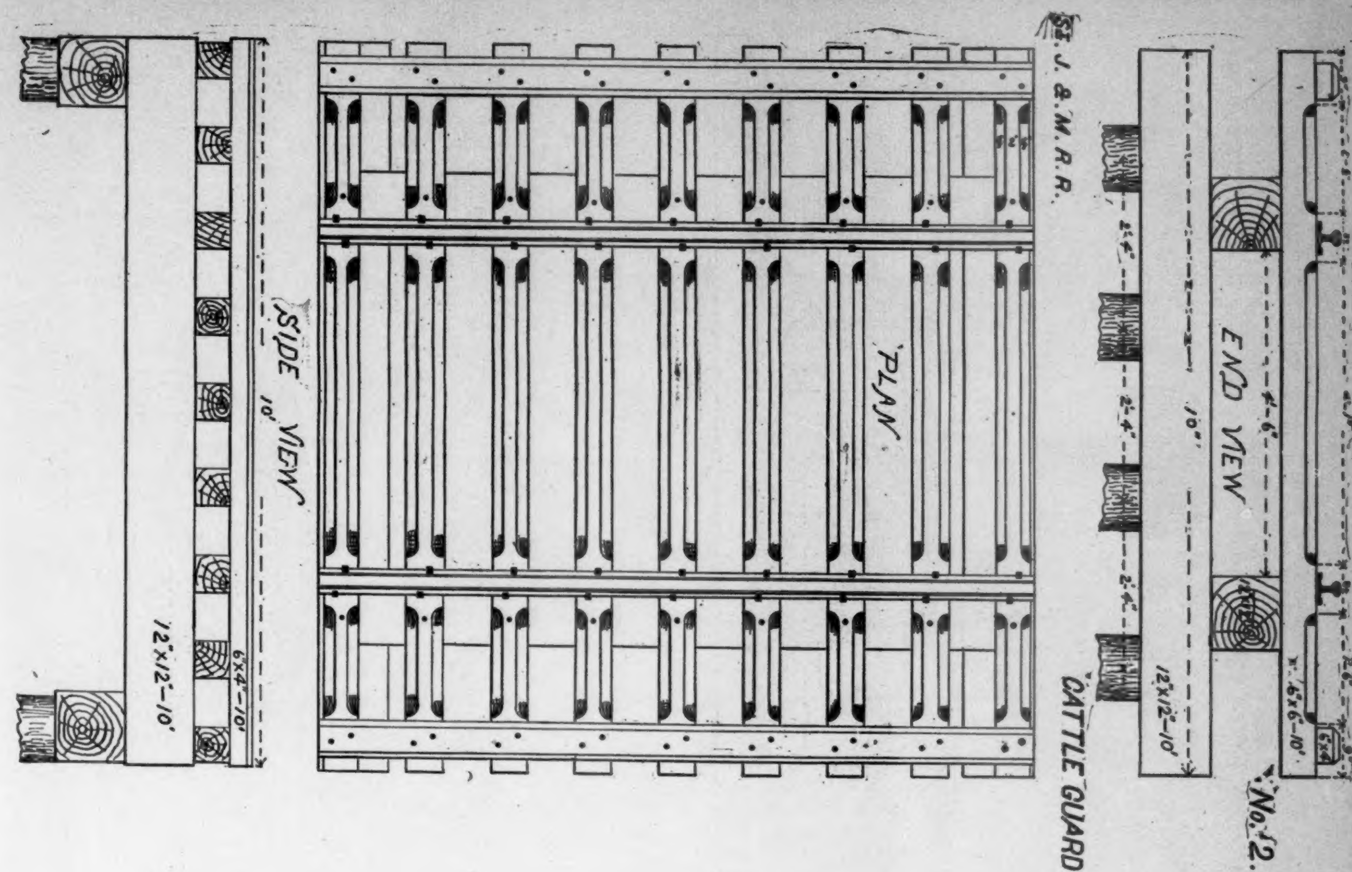
Fig. 3. Plate VI, shows in detail the chair to be used with the T-rail stringer. The bills of material for these cattle-guards are given below :

No. 6. Bill of Material for T-rail Cattle-guard.
Atchison, Topeka & Sante Fé Railroad.

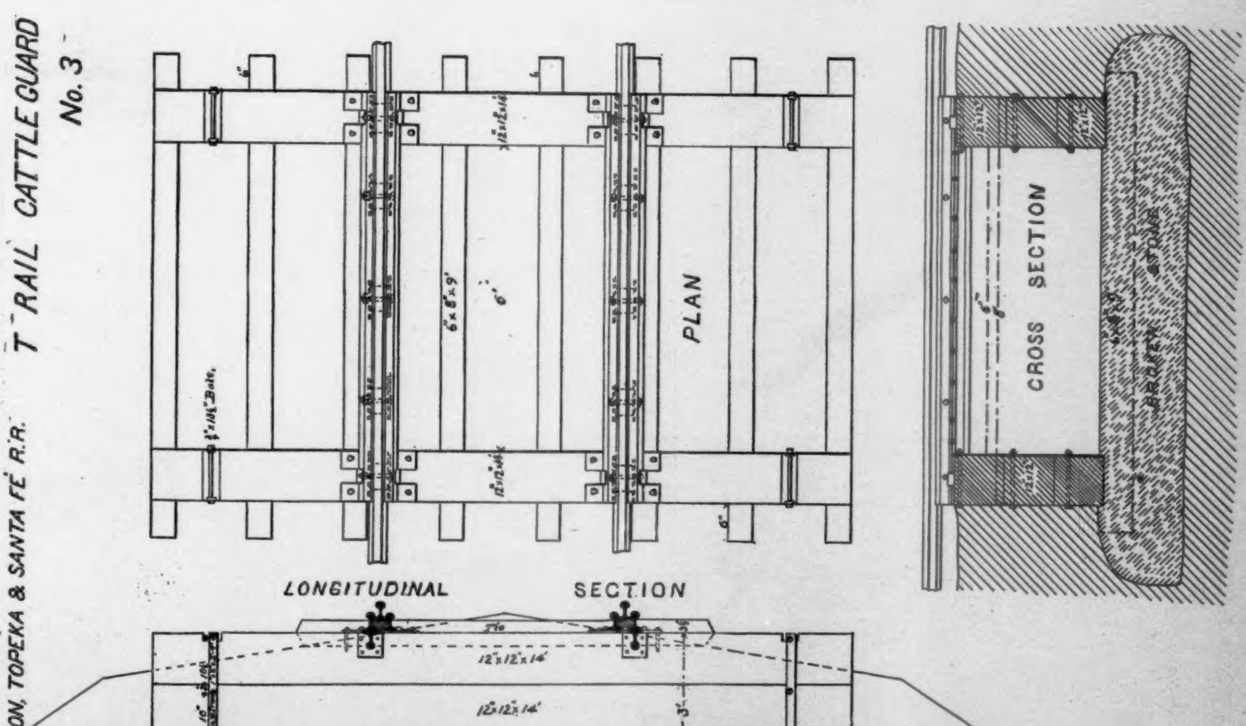
Size.	Material.	Number. Cut.	Fill.	Level.
Cub. yds.	Broken stone	8	8	8
6 in. × 8 in. × 9 ft.	Sleepers	8	8	8
12 in. × 12 in. × 14 ft.	Sills	6	6	6
3 in. × 12 in. × 16 ft.	End of guard (cut to 8 ft.)	3	..	3
6 in. diam., 10 ft. long.	Good cedar posts	4	4	4
6 in. diam., 10 ft. long	Good cedar posts	4	4	4
1 in. × 6 in. × 16 ft.	Fencing stuff	12	16	12
1 × 2 × 2–9	Wrought-iron straps, ¾ in. hole	8	8	8
¾ in. × 13½ in.	Bolts and nuts, thread 3 in.	12	12	12
	Chairs as per plan, Plate VI	4	4	4
	Track-spikes	16	16	16
6 ft. long	T-rails, riveted together	2	2	2
8 ft. long	T-rails, riveted together.	4	4	4
	Cast-iron blocks, as per plan, to correspond to size of rail	10	10	10
1 in. × 8 ¾ in.	Bolts with nuts and jam-nuts	10	10	10
12d.	Nails	3 lbs.	3 lbs.	3 lbs.
⅜ in × ⅜ in. × 7 in.	Spikes for end-boards	40	..	40

No. 7. Bill of Material for T-rail Cattle-guard.
Atchison, Topeka & Santa Fé Railroad.

Size.	Material.	Number. Cut.	Fill.	Level.
12 in. diam. (small end).	Piles, length required	8	8	8
12 in. × 12 in. × 14 ft.	Sills	2	2	2
2 in. × 12 in. × 14 ft.	Retaining plank	4	..	4
2 in. × 12 in. × 18 ft.	Retaining plank	..	2	..
2 in. × 12 in. × 18 ft.	Retaining plank	..	2	..
2 in. × 12 in. × 18 ft.	Retaining plank (cut to 9 ft.)	..	2	..
3 in. × 12 in. × 16 ft.	End of guard (cut to 8 ft.)	3	..	3
6 in. diam., 12 ft. long.	Good cedar posts	4	4	4
6 in. diam., 8 ft. long.	Good cedar posts.	4	4	4
1 in. × 6 in. × 16 ft.	Fencing stuff	12	16	12
⅞ in. × 20 in.	Drift-bolts	4	4	4
30d.	Nails	3 lbs.	3 lbs.	3 lbs.
	Chairs as per plan, Plate VI	4	4	4
	Track-spikes	16	16	16
6 ft. long	T-rails, riveted together	2	2	2
8 ft. long	T-rails, riveted together	4	4	4
	Cast-iron blocks, as per Plate V, to correspond to size of rail	10	10	10
1 in. × 8 ¾ in.	Bolts, with nuts and jam-nuts.	10	10	10
10d.	Nails	2 lbs.	2 lbs.	2 lbs.
⅜ in. × ⅜ in. × 7 in.	Spikes for end-planks	40	..	40



S. J. & M. R.R.
CATTLE GUARD
No. 2.
SIDE VIEW
10'
12"x12"–10'
6"x4"–10'
PLAN
END VIEW

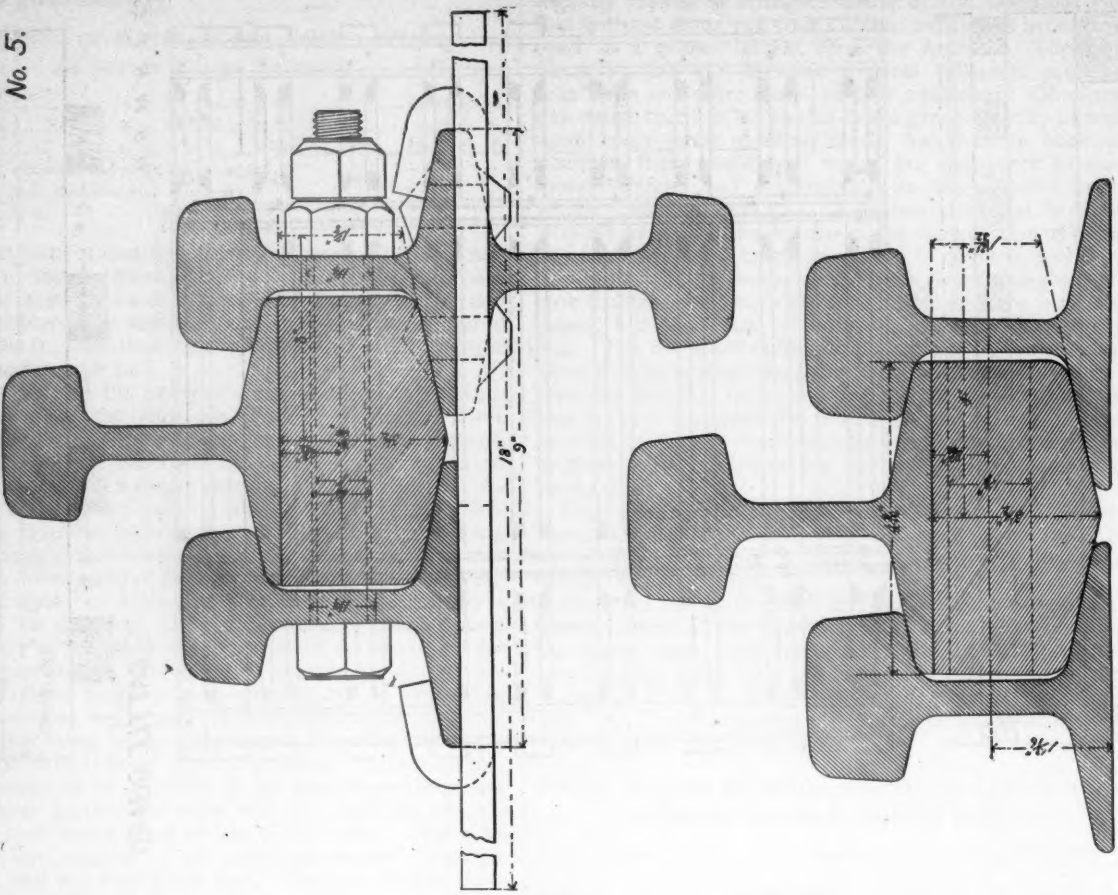


ATCHISON, TOPEKA & SANTA FE R.R.
T RAIL CATTLE GUARD
No. 3
PLAN
6"x8"x9'
LONGITUDINAL SECTION
12"x12"x14'
BROKEN STONE
CROSS SECTION

ATCHISON TOPEKA & SANTA FE R.R.

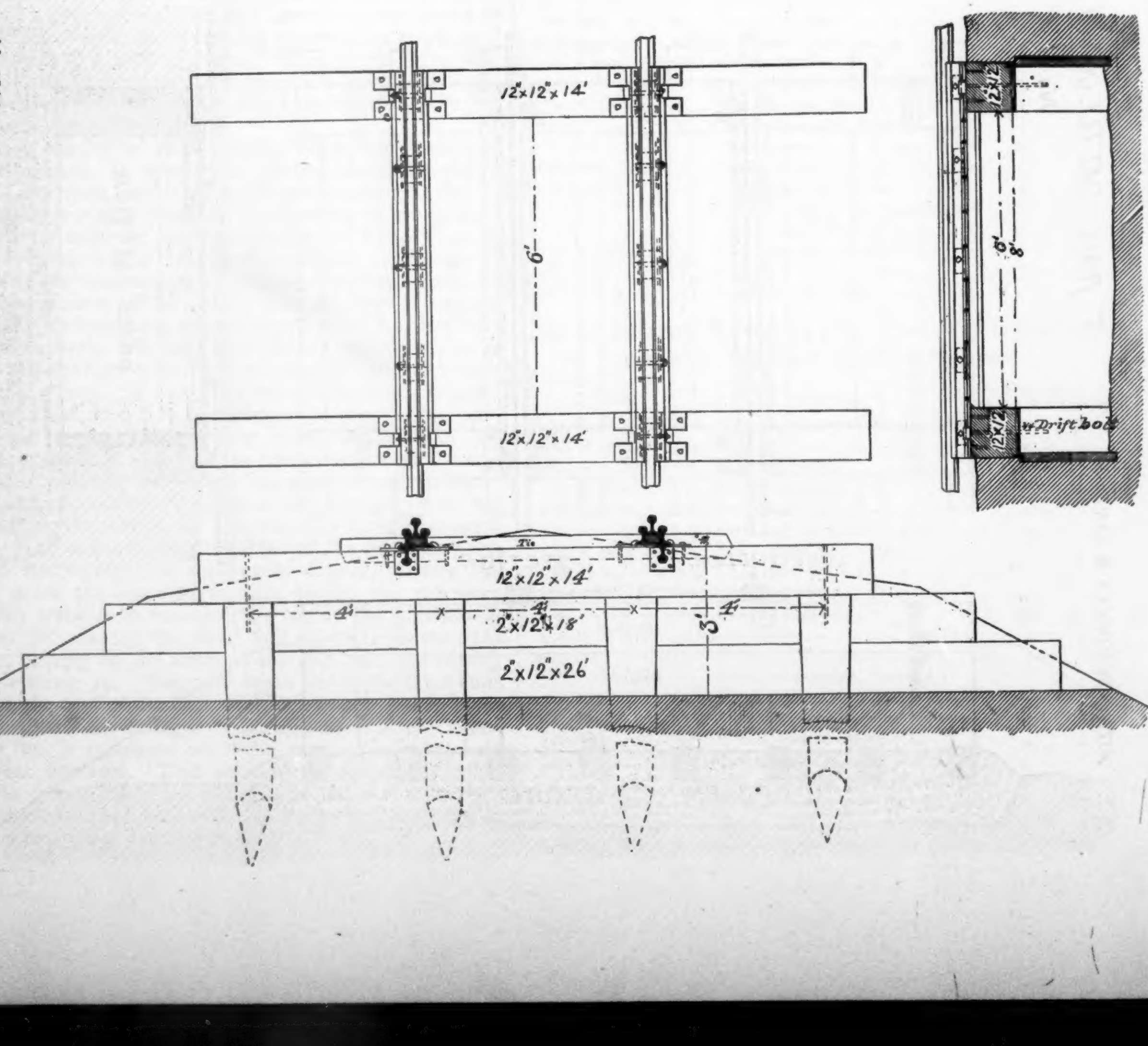
T RAIL STRINGER

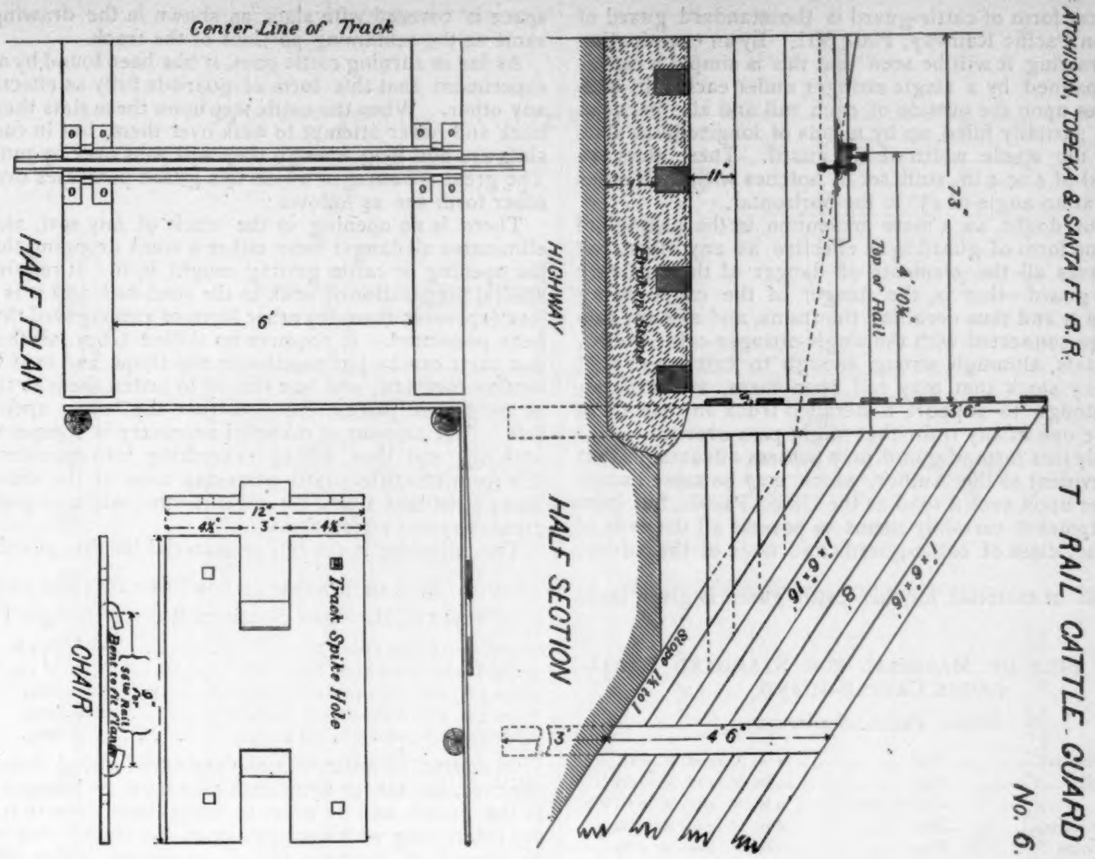
No. 5.

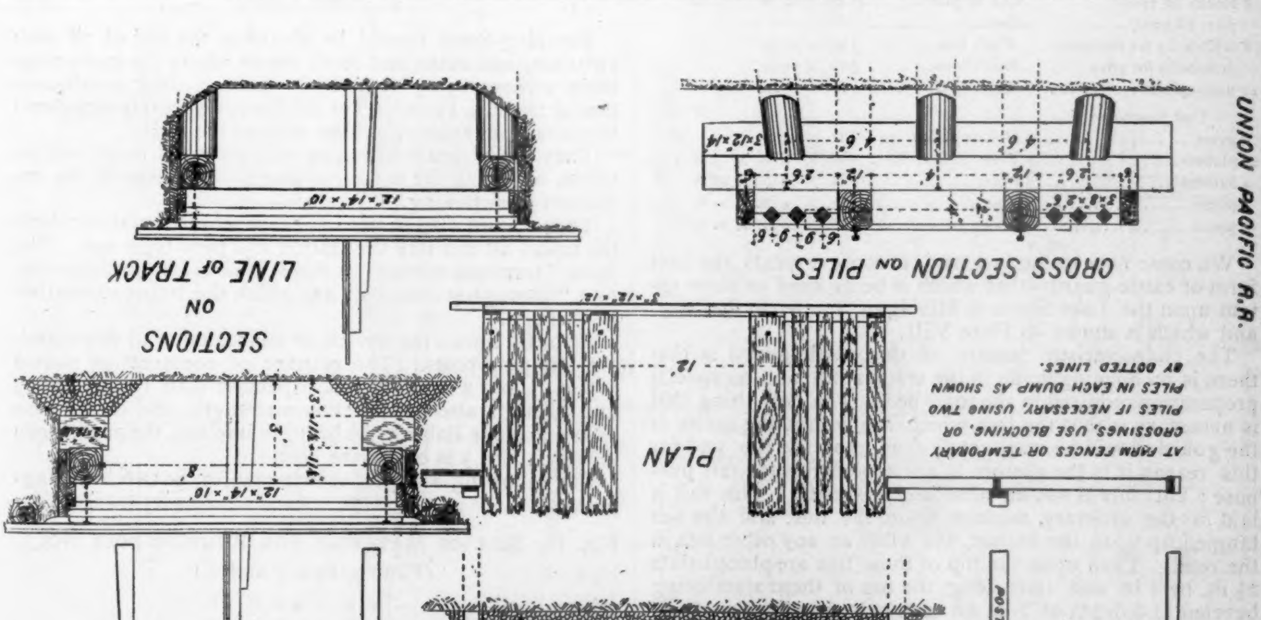


ATCHISON TOPEKA & SANTA FE R.R. T RAIL CATTLE GUARD

No. 4.




ATCHISON, TOPEKA & SANTA FE R.R.
T RAIL CATTLE GUARD
No. 6.
Center Line of Track
HIGHWAY
HALF PLAN
HALF SECTION
Top of Rail
Broken Stone
Slope 1½ to 1
Track Spike Hole
CHAIR
Bent to fit Flange


UNION PACIFIC R.R.
CATTLE GUARD
No. 7
CROSS SECTION ON PILES
PLAN
AT FARM FENCES OR TEMPORARY CROSSINGS, USE BLOCKING, OR PILES IF NECESSARY, USING TWO PILES IN EACH DUMP AS SHOWN BY DOTTED LINES.
SECTIONS ON LINE OF TRACK
CROSS SECTION ON BROKEN STONE
POST 8' LONG

The next form of cattle-guard is the standard guard of the Union Pacific Railway, Plate VII. By an examination of the drawing it will be seen that this is simply a cattle-guard spanned by a single stringer under each rail, with the spaces upon the outside of each rail and also between the rails partially filled up by means of longitudinal slats running the whole width of the guard. These slats are composed of 4 × 4 in. stuff set in notches with their sides inclined at an angle of 45° to the horizontal.

Without doubt, as a mere prevention to the passage of cattle, this form of guard is as effective as any other, but it possesses all the elements of danger of the ordinary cross-tie guard—that is, the danger of the cattle being caught in it and thus derailing the trains, and also the disadvantage connected with the single-stringer cattle-guard, as the slats, although strong enough to catch and hold firmly any stock that may fall upon them, are still not strong enough to support a derailed truck in case there should be one in any train that might pass over it.

Possibly this form of guard may possess advantages that are not evident to the Author, which may be some excuse for its use upon such a road as the Union Pacific, but from his standpoint it certainly seems to possess all the evils of every other class of cattle-guards and none of the advantages.

The bill of material for this cattle-guard is given herewith:

No. 8. Bill of Material for Standard Broad-gauge Cattle-guard.

Union Pacific Railway.

2 track-stringers	Oak	12 in. × 12 in. × 10 ft.
2 caps or sills	Oak	12 in. × 12 in. × 12 ft.
6 slats	Oak or pine	4 in. × 4 in. × 10 ft. 2 in.
2 outside stringers	Pine	6 in. × 12 in. × 10 ft.
8 furring strips	Pine	1 in. × 6 in. × 2 ft.
2 plank	Oak or pine	3 in. × 12 in. × 12 ft.
– plank (see note)	Oak or pine	3 in. × 12 in. × 14 ft.
4 slat-supports	Oak or pine	3 in. × 8 in. × 2 ft. 6 in.
8 blocks (if used)	Oak or pine	12 in. × 12 in. × 18 in.
– piles (if used)	Oak	
8 drift-bolts for stringers	Wro't iron	$\frac{3}{4}$ in. × 22 in.
– drift-bolts for piles	Wro't iron	$\frac{3}{4}$ in. × 22 in.
12 boat-spikes	Wro't iron	$\frac{1}{2}$ in. × 10 in.
Two fence-panels.		
6 posts	Oak or cedar	8 ft. long.
27 pickets	Pine	1 in. × 6 in. × 5 ft. 3 in.
4 battens	Pine	1 in. × 4 in. × 12 ft.
4 pieces	Pine	2 in. × 4 in. × 12 ft.
2 pieces	Pine	3 in. × 4 in. × 12 ft.

We come now to the last, and, in some respects, the best form of cattle-guard—that which is being used to some extent upon the Lake Shore & Michigan Southern Railway, and which is shown in Plate VIII.

The characteristic feature of this cattle-guard is that there is no opening made in the track at all, and no special preparation required in the road-bed. The only thing that is necessary is that the ties which are within the limits of the guard should be moderately even upon the top, and for this reason it is the custom to use sawed ties for this purpose; but this is not an absolute necessity. The rail is laid in the ordinary manner upon the ties, and the ties tamped up upon the ballast, the same as any other ties in the road. Then upon the top of these ties are placed slats $2\frac{1}{2}$ in. by 4 in. and 10 ft. long, the top of these slats being beveled to a depth of 2 in. on each side, leaving the top of the slat $\frac{1}{2}$ in. wide; these slats run in the direction of the rail, and are placed upon the ties, being held 2 in. apart by means of filler-blocks 2 in. × 2 in. × 8 in. at each end of the slats. These slats and fillers are held together in sections by means of long bolts running through each end, as shown in the drawing. By this means each section can be taken up and the track work carried on underneath in the usual manner and then replaced and spiked to the ties. The ends of these slats are beveled off, in order to do away with the danger of their being caught and torn up by any hanging brake rods there may be in the trains.

In the case of double track it is only necessary to introduce three extra ties or three ties of length sufficient to cross the intervening space between the tracks. This space is covered with slats, as shown in the drawing, the same as the remaining portions of the track.

As far as turning cattle goes, it has been found by actual experiment that this form of guard is fully as effective as any other. When the cattle step upon these slats they turn back and never attempt to walk over them, but in case the slats are not long enough they will pass over by jumping. The great advantages which this guard possesses over any other form are as follows:

There is no opening in the track of any sort, and this eliminates all danger from either a truck dropping through the opening or cattle getting caught in it. It requires no special preparation or work in the road-bed, and it is much less expensive than any other form of cattle-guard that has been presented. It requires no skilled labor, all the various parts can be put together in the shops, and sent to any section foreman, who has simply to fasten them to the ties in the proper places and construct the fences upon each side. The amount of material necessary is comparatively nothing, and thus, taking everything into consideration, this form of cattle-guard possesses none of the disadvantages attendant upon the other forms, while it possesses great inherent advantages.

The following is the bill of material for this guard:

No. 9. Bill of Material for Slat Cattle-guard.

Lake Shore & Michigan Southern Railway (Single Track).

20 slats, as per plan, Plate VIII	$2\frac{1}{2}$ in. × 4 in. × 10 ft.
38 filler-blocks, as per plan, Plate VIII	2 in. × 2 in. × 8 in.
4 iron $\frac{3}{4}$ in. rods, with nuts and washers	18 ft. long.
2 iron $\frac{3}{4}$ in. rods, with nuts and washers	29 ft. long.
2 iron $\frac{3}{4}$ in. rods, with nuts and washers	27 ft. long.

Of course, in order to make any cattle-guard thoroughly effective, the fences upon each side must be brought down to the guard, and in order to bring them close to it without interfering with the passage of the trains, they should be sloped at an angle of 45°, as shown in the different plates.

CHAPTER IV.

BUMPING-POSTS.

Bumping-Posts should be placed at the end of all stub switches, and at the end of all tracks where the track stops short without being connected with any other continuous line of track. The object of the bumping-post is to prevent the cars from running off the ends of the rails.

They are of great use upon stub switches in all station yards, owing to the usual extreme carelessness of the engineers in switching.

They should also be used in every terminal station where the trains all run into the station and then back out. The term "terminal station" is here used in contradistinction to a "through station," or one where the trains run entirely through.

Plate IX shows the details of construction of two standard bumping-posts. The manner of construction shown in figs. 1 and 2 is much less expensive than that in figs. 3 and 5, but it also has much less strength, and in any case where they are liable to be brought into use, the post shown in figs. 3 and 5 is by far the best.

The following are bills of material for the two bumping-posts:

No. 10. Bill of Material for Bumping-post No. 1.

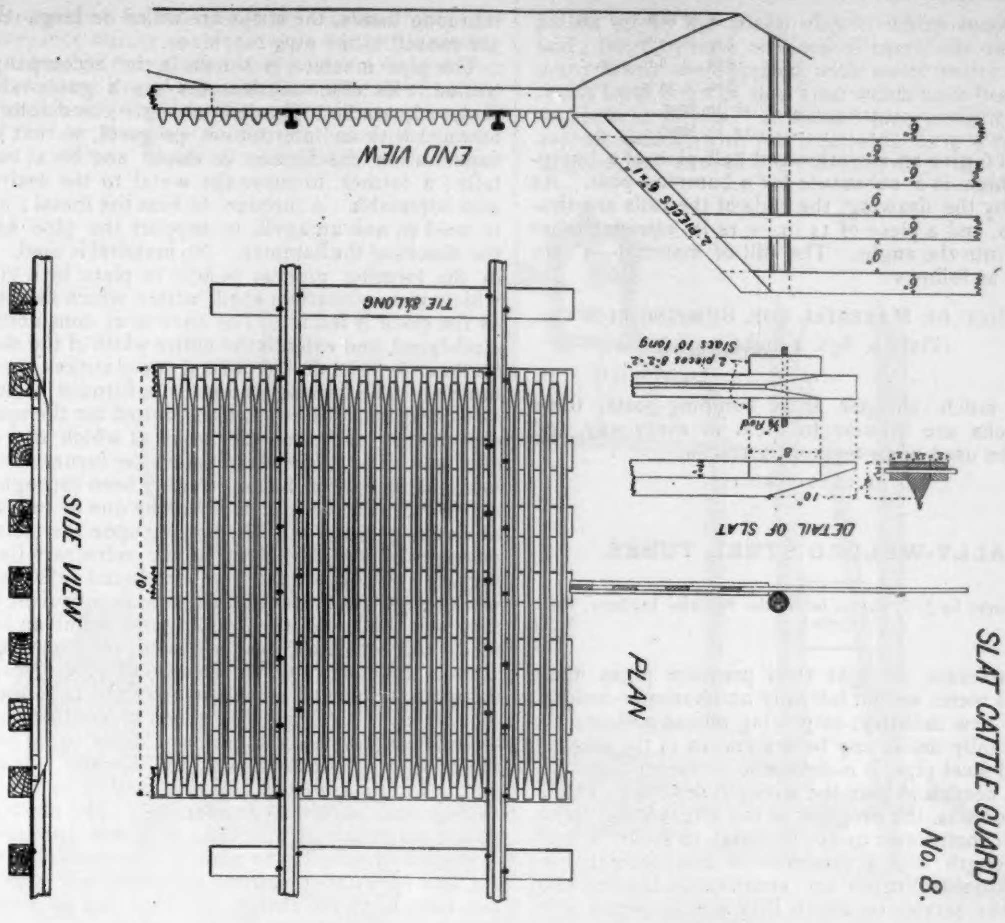
(Plate 9, figs. 1 and 2.)

1 piece	14 in. × 14 in. × 8 ft. 5 in.
1 piece	14 in. × 14 in. × 30 ft.
1 piece	14 in. × 14 in. × 16 ft.
1 bolt	$1\frac{1}{2}$ in. × 15 in., with nut and washer.
2 bolts	$1\frac{1}{4}$ in. × 27 in., with nut and washer.
1 rod	$1\frac{1}{8}$ in. × 7 ft. 3 in., with head, nut, and washer.
1 casting	2 in. × 14 in. × 20 in.

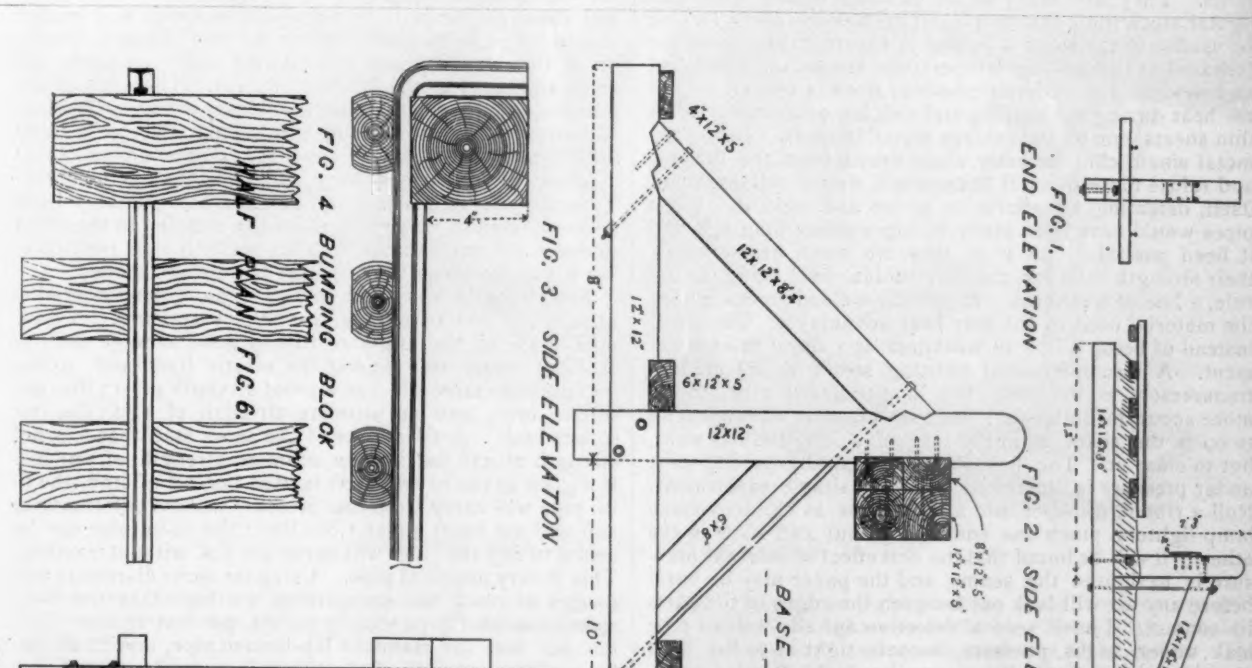
No. 11. Bill of Material for Bumping-post No. 2

(Plate 9, figs. 3 and 5.)

2 pieces	12 in. × 12 in. × 18 ft.
2 pieces	12 in. × 12 in. × 5 ft.
2 pieces	8 in. × 12 in. × 5 ft.
2 pieces	12 in. × 12 in. × 8 ft. 6 in.
2 pieces	12 in. × 12 in. × 9 ft. 6 in.
2 pieces	6 in. × 8 in. × 4 ft. 6 in.



SLAT CATTLE GUARD No. 8.



BUMPING POST No. 9

1 piece	4 in. × 12 in. × 5 ft.
4 bolts	¾ in. × 17 in.
2 rods	1¼ in. × 8 ft. 3 in.
4 bolts	¾ in. × 15 in.
34 boat-spikes	18 in. long.
16 spikes	12 in. long.

Figs. 4 and 6 give an elevation and half-plan of a bumping-block, which is a substitute for a bumping-post. As will be seen by the drawing, the ends of the rails are simply turned up, and a piece of 14 in. × 14 in. square timber fitted tightly into the angle. The bill of material—a very brief one—is as follows:

No. 12. Bill of Material for Bumping-block.
(Plate 9, figs. 4 and 6.)

1 piece	14 in. × 14 in. × 7 ft.

Although much cheaper than bumping-posts, these bumping-blocks are inferior to them in every way, and should only be used upon temporary tracks.

(TO BE CONTINUED.)

SPIRALLY-WELDED STEEL TUBES.

(Abstract of remarks by J. C. Bayles, before the Franklin Institute, Philadelphia.)

THE manufacture of light steel pressure pipes made from strips of metal wound laterally and hammer-welded, is an entirely new industry, employing means and producing results wholly unlike any before known in the arts.

In iron and steel pipe, it is desirable to use no more material than is needed to give the strength desired. This is true of all products, the progress of the arts tending steadily to a good constructive use of material, to secure a maximum of strength with a minimum of dead weight. As the rule, lap-welded tubes are enormously heavier than anything in the service to which they are subjected warrants. They are made so for no other reason than that lighter stock than that employed in making them cannot be used. If the stock is heated in sheets, drawn from the furnaces at the welding temperature, shaped on a mandrel and welded, a considerable body of stock is needed to hold the heat during the shaping and welding processes. With thin sheets one of two things would happen: either the metal would chill instantly when drawn from the furnace and refuse to weld, or, if hot enough, would collapse upon itself, defeating all efforts to shape and weld it. Light pipes would have been made by lap-welding long ago had it been possible. As it is, they are much heavier than their strength calls for, the longitudinal weld being, as the rule, a line of weakness. In spirally-welded pipes we have the material used to the very best advantage. The weld, instead of being a line of weakness, is a spiral re-enforcement. A circumferential twisting strain is not created transversely to the weld, but longitudinally; or, to be more accurate, obliquely; and such pressure does not tend to open the seam, as in the case of a longitudinal weld, but to close it. The behavior of a spirally-welded pipe under pressure is illustrated by a very simple experiment. Roll a ribbon of paper into a spiral tube, as children make lamp-lighters, pinch one end tightly shut and blow in the other. It will be found that the first effect of internal pressure is to tighten the seams, and the paper may be burst before any air will leak out between the edges of the parts in contact. I have seen a defective spirally-welded pipe leak under 20 lbs. pressure, become tight at 50 lbs., and remain tight up to 350 lbs. per square inch. Under an internal bursting strain, the strength of a spirally-welded tube is found in the testing machine to be as great as the theoretical strength of the stock.

The process of manufacture is simple and inexpensive, but has entailed many and serious difficulties. These, however, have been overcome. Steel of suitable quality—*i.e.*, weldable, and having a tensile strength of 65,000 lbs. per square inch, with about 50 per cent. reduction of area, and 15 to 18 per cent. elongation, is rolled in grooves to the proper width, and as long as may be convenient. These strips are welded end to end in a machine built for the purpose, which works very well. As they are welded into long bands, the strips are rolled on large reels, which are passed to the pipe machines.

The pipe machine is shown in the accompanying illustration. Its essential features are a guide-table for the skelp, adjustable to the desired angle; feed-rolls, to pass it forward with an intermittent progress, so that it shall advance when the former is raised and be at rest when it falls; a former, to curve the metal to the desired radius, also adjustable; a furnace, to heat the metal; a hammer, to weld it, and an anvil, to support the pipe and receive the shocks of the hammer. No mandrel is used. The pipe in the forming process is held in place by a pipe-mould, which is a cylindrical shell, within which the pipe rotates as the stock is fed in. The anvil is of considerable mass, steel-faced, and extends the entire width of the skelp. The hammer is light, and at normal speed strikes 350 blows per minute. The heating is done in a furnace so constructed as to heat both the edges to be united for the space of several inches ahead of the point at which the welding is effected. The upper skelp enters the furnace flat, and the lower skelp curved, having already been through the forming-jaws. The heat is imparted by one or two blow-pipes of water, gas, and air, discharging upon the metal through passages of suitable form in the refractory lining of the furnace. One gas-flame has been found sufficient, but two work better; and besides being more convenient to control, they heat the metal more rapidly and permit an accelerated feed. As very little gas is wasted, the greatest economy attends the most rapid production of pipe, irrespective of the quantity burned, which in any case is about 30 ft. per foot of welded seam. The speed of production depends, as stated, upon the thickness of stock to be heated, and the relation of width of skelp to diameter. It averages a foot per minute to each machine, and it is probable this average can be raised considerably. The machines are so nearly automatic in operation that very little skilled labor is needed in running the plant. The operator has his gas, air, and feed under control by convenient means, and varies their relations until he has them just as he wants them. He can see the edges as they emerge from the furnace, and about all the skill he needs is that which will enable him to judge by its color whether the iron is above, below, or at the welding-heat. Unskilled labor prepares the stock and removes the finished product. The ends of the pipe are cut square by suitable machinery without reversing, and after testing and treating with asphalt, the pipe is ready for shipment. As may be supposed, all the difficulties of mechanical development have centred in the pipe machine. To make this satisfactory in operation has probably been no more serious task than is usually entailed in the effort to make old mechanical motions perform new functions, but it has consumed a great deal of time and money.

The strengths attainable in light pipe, if the material is used to the best advantage, are quite surprising. A 6-in. pipe, made of No. 14 gauge iron of good average quality, showing under test 33,000 lbs. elastic limit and 50,000 lbs. ultimate strength, has a proof strength of 913 lbs. per square inch, and an ultimate strength of 1,383 lbs. per square inch. A 12-in. pipe of the same stock has a proof strength of 456 lbs. and an ultimate strength of 691 lbs. If a good grade of soft steel is used instead of iron, the 6-in. pipe will carry 1,106 lbs. pressure without deformation, and will not burst under 1,800 lbs.; the 12-in. pipe can be tested to 475 lbs., and will carry 900 lbs. without fracture. This is very practical pipe. Using the same diameters and gauges of stock for comparison, we find that the 6-in. spirally-welded pipe weighs 5.2 lbs. per foot against 18.77 lbs. per foot for standard lap-welded pipe, and 28.28 lbs. for medium cast-iron pipe; the 12-in. spirally-welded pipe weighs 10.46 lbs. against 54.65 lbs. for lap-welded, and 77.36 for medium cast iron.

Owing to its superior advantages, we shall use steel exclusively in future. It is 25 per cent. stronger than good iron, works better and costs less per pound.

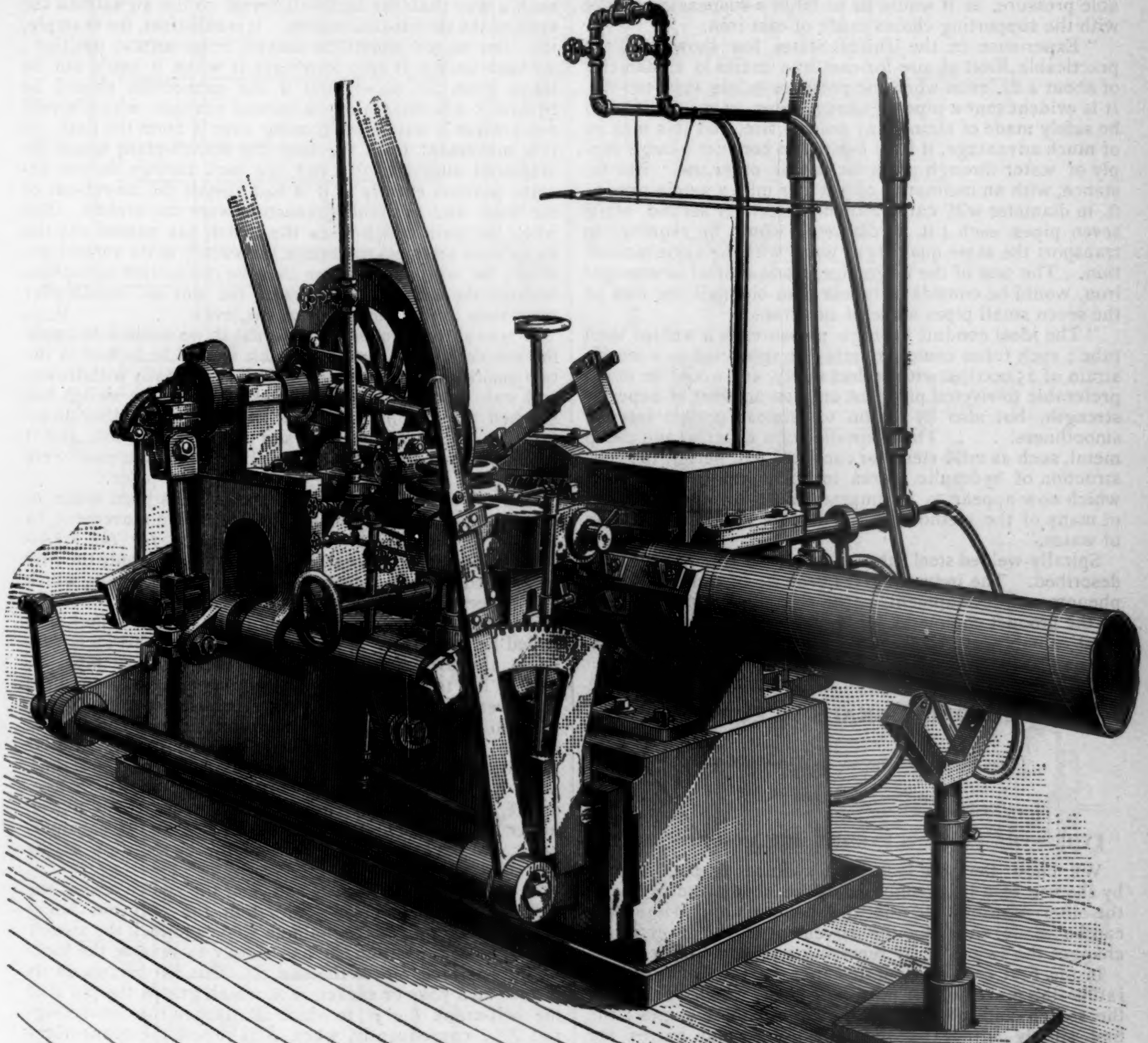
The advantages of spirally-welded tubes over any other form of pressure pipes, as regards economy of transportation and handling, are very marked, as appears from comparisons of weights.

The question of durability in service is one which naturally suggests itself when light steel or iron pipes are discussed. Experience on the Pacific Coast seems to have

settled this question, as the cheap expedients adopted for water-conveyance during the days when hydraulic mining was most extensively conducted, have been followed ever since in permanent engineering works. The best attainable data on this subject which I have found are presented in a paper read by Hamilton Smith, Jr., before the British Iron & Steel Institute. Much of the information contained in this paper is quite surprising, especially in the case of the two mains across Humbug Cañon. These pipes were laid in 1868.

"They are of 26 in. diameter, 1,194 ft. long, of common iron $\frac{1}{16}$ in. in thickness, single-riveted. During all this time they have been delivering water under 120 ft. head, and Mr. Smith gives the maximum tensile strain in pounds on the metal per square inch as 11,500. Large as these figures look, they are simply the result of applying to the conditions given in Rankine's well-known formula for their cylindrical shells.

Riveted pipe in its best estate labors under the disadvantage of inherent structural weakness, and liability to rust between the overlapping edges and around the rivets. Pipes of this character on the Pacific Coast are very roughly tarred in position, and the coating is quite liable to be pulled off by the adobe clay in which most of them are laid; but they have a record of useful life since 1853, and many towns are supplied with water under considerable heads from pipes of this kind which have been more than 20 years in service. A welded pipe carefully coated with asphalt should, with fair treatment, have a record at least as good, and probably much better.



MACHINE FOR MAKING SPIRAL-WELD TUBES.

The coupling of light-pressure pipes involves no difficulties, but it entails new methods. These are convenient and inexpensive, and make perfectly tight joints. The couplings are chiefly of cast iron, and their form depends upon the service in which the pipe is to be employed. Steam, water, petroleum, compressed air and gas, all present different problems in couplings, but no difficulties which have not already been fully met. The couplings are as practical as the pipe. The one generally preferred is the "trumpet flange." The pipe is slipped through the flange, and the projecting end is expanded and laid flat against the face of the flange. The ends of the pipes are thus brought in contact with the gaskets, making perfect joints under all circumstances.

Spirally-welded tubes are adapted for every use calling for pressure pipes. In the paper, before referred to, Mr.

Hamilton Smith, Jr., after reciting American engineering experience with light iron tubes, concludes as follows:

"The query presents itself: Why should not wrought iron or, still better, steel, be used for conduit pipes in preference to cast iron? If it answers the desired purpose in California, why should it not do so in other parts of the world? To one, like myself, who has for years been accustomed to the California practice, it seems as irrational to build a pipe of cast iron carrying water under considerable pressure, as it would be to build a suspension bridge with the supporting chains made of cast iron.

"Experience in the United States has shown that the practicable limit of size for cast-iron mains is a diameter of about 4 ft., even when the pressure is less than 100 lbs. It is evident that a pipe of wrought iron or mild steel can be safely made of almost any desired size, and this may be of much advantage, if it be desired to conduct a large supply of water through pipes for city or other use. For instance, with an inclination of 3 ft. per mile a single pipe 8½ ft. in diameter will carry 280 cubic feet per second, while seven pipes, each 4 ft. in diameter, would be required to transport the same quantity of water with the same inclination. The cost of the large pipe, made of steel or wrought iron, would be considerably less than one-half the cost of the seven small pipes made of cast iron.

"The ideal conduit for high pressures is a welded steel tube; such tubes could probably be subjected to a tensile strain of 25,000 lbs. with perfect safety, and would be much preferable to riveted pipe, not only on account of superior strength, but also by reason of almost perfect interior smoothness. . . . The adaptation of a superior and cheap metal, such as mild steel, for conduits, will permit the construction of hydraulic works in many parts of the world which now appear to be impracticable, owing to the cost of many of the methods still in use for the transportation of water."

Spirally-welded steel tubes meet all the conditions above described. The industry gives promise of rapid and even phenomenal development, as the cheapness and excellence of the product command for it instant recognition as the most valuable of recent contributions to engineering materials.

RAILROAD SIGNALS IN EUROPE.

(From the *Revue Generale des Chemins de Fer.*)

(*Continued from page* 78.)

VIII.—THE SAXBY & FARMER DUPLEX DETECTOR.

We know that the locking of switches in place is done by the use of a bolt, which holds the switch-rod in one or the other position, and that the displacement of the lock can be made either by the movement of the lever which changes the switch or by reversing a separate lever.

In the first case—as, for instance, in the Dujour apparatus—the movement of the single lever, which works both the switch and the lock, is divided into three stages: the first simply withdraws the bolt, the second moves the switch-plate, and in the third the bolt is again moved and locks the switch in its new position.

It is objected to this arrangement—and this objection does not apply simply to the Dujour system, but to the principle on which it is based—that only one-third of the movement of the lever is utilized in moving the switch itself, and, besides, that it would not reveal to the signalman any break or interruption in the transmission of the movement. This last objection could be partially removed by furnishing the switch with controlling apparatus, but it is still more serious than the first; for if the transmission is broken, and if the signalman reverses the lever, believing that the switch keeps the position which he intended to give it, he would then operate the signal levers authorizing the movement of the train in a different direction to that which it would really take, and thus all the guarantees resulting from interlocking would completely disappear.

It is in answer to this objection, which is, perhaps, theoretic, but nevertheless serious, that recourse has been had to separate levers for operating the switch-locks.

In this second system, the lock and the stop which is used to prevent any movement of the switch while a car is passing over it is worked by a special lever which is interlocked with the switch-lever, and also with the levers moving with the signal authorizing the passage of trains over the switch.

In this case the lock may be simple or double-acting.

When we use a simple lock to hold the switch in one of its two positions, we can always arrange the apparatus in such a way that the lock will reveal to the signalman the state of the switch-connection. It is sufficient, for example, that the switch should be locked in its normal position; we then unlock it only to reverse it when it could not be taken from the point, and if the connection should be broken it will remain in its normal position, which would not prevent a train from passing over it from the heel; in this movement from the heel the switch-plate would be displaced automatically and the lock thrown in the reverse position exactly as if it had obeyed the movement of the lever and as if the connection were not broken. But when the train which takes the switch has passed and the signalman attempts to restore the switch to its normal position, he will at once see that the connection is broken, because the lock could not enter the slot and would offer resistance to the movement of the lever.

It would be altogether different if we wished to apply the simple lock to a switch which should be locked in the two positions; in this case the bolt is normally withdrawn, and can only be thrown into place when the switch has reached the end of its course in one or the other direction; as there is always a slot opposite the bolt, and it could always be thrown even if the connections were broken and the switch had not changed its place.

It is for this reason that an attempt has been made to secure a double-acting lock with alternative movement, in such a way as *to distinguish the locking for the right-hand direction from that for the left hand;* only the first types tried depended upon the use of vertical levers, which it was necessary to move in one direction or the other.

The new arrangement applied by Saxby & Farmer, and called by them the *Duplex Detector,* avoids this inconvenience, the locking-lever being of the ordinary type, arranged like the others, while by an ingenious arrangement the reverse position given it corresponds, according to the case, to locking for the right-hand or the left-hand track.

This arrangement is applied to a signal cabin, similar to that shown in figs. 14, 15, and 16 (December number, page 558), the special applications being shown in figs. 47, 48, and 49). They consist of an arrangement placed under the cabin by which the movement of the bar operating the lock can be governed by the position of the switch.

In fig. 47 the two bars, K and S, of the switch and of the lock are in their normal situation, the bolt not being thrown. Now, if the signalman wishes to lock the switch in this normal position, he has simply to reverse the locking-lever which moves the bar S. This bar carries on its lower end a yoke or socket, $m\ n$, which grasps the pin l^1 of the bell-crank $l^1\ o^1\ p^1$, to which is attached the connecting-rod T^2; consequently, when S is raised the connecting-rod T^2 is moved in the direction shown by the arrow at a. This connection is prolonged beyond the pin P, and is attached to a second lever, $p^2\ o^2\ l^2$, placed in a reversed position from the first, and when the connecting-rod is moved in the direction a, the lever $p^2\ o^2\ l^2$ moves without producing any further effect, since its extremity, p^2, is free.

If it is intended to lock the switch in the opposite position and to return to the normal position, shown in fig. 47, it is necessary to begin by reversing the switch-lever which would draw up the bar K, the lower end of which moves by the bell-crank lever $l^3\ o^3\ p^3$ the connecting-rod T^1; it follows that this bar is then moved in the direction c, and the switch-plate is drawn from one position into the opposite one. On the bell-crank $l^3\ o^3\ p^3$ there is mounted at the point i a bar h carrying a lug r in which the extension t of the bar S engages. When the switch is reversed this bell-crank $l^3\ o^3\ p^3$ moves t, and the whole bar K in the direction f in such a way that the fork $m\ n$ leaves the pin l^1 and takes hold of l^2; thus the movement of the switch has the effect of changing the mode of action of the connecting-bar of the lock, which, nevertheless, when it is

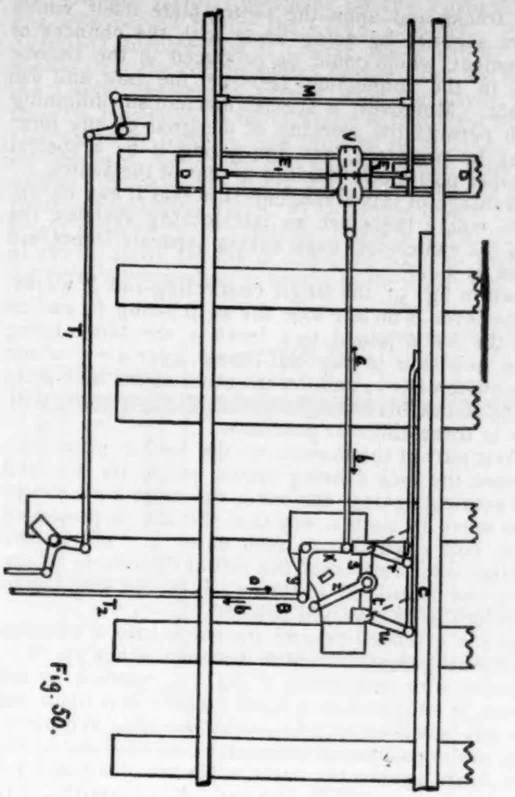


Fig. 50.

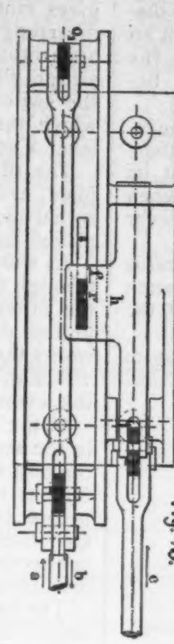


Fig. 48.

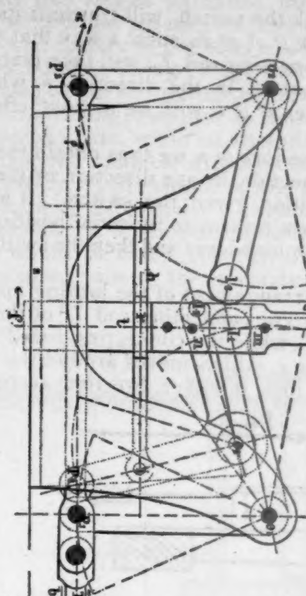


Fig. 47.

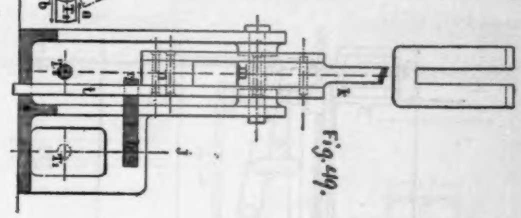


Fig. 49.

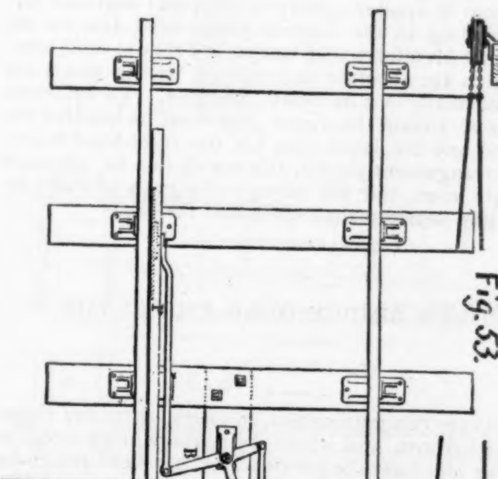


Fig. 53.

Fig. 51.

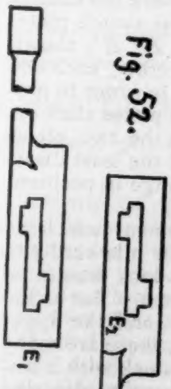


Fig. 52.

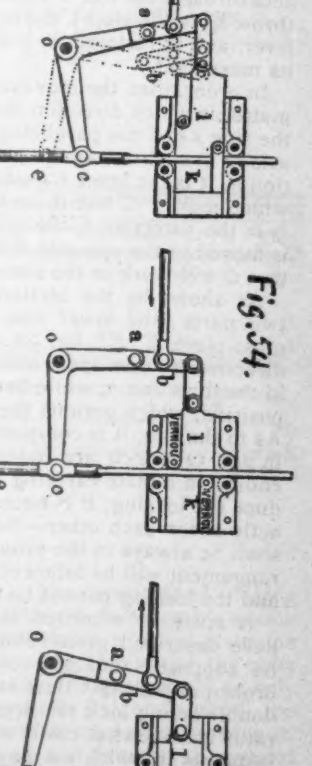


Fig. 54.

moved, in order to lock the switch, will transmit its movement to the bell-crank $l^2\, o^2\, p^2$ in such a way that the displacement of the connecting-rod T^2 will take place in an opposite direction—that is, in the direction *b*, while the movement of the lever $p^1\, o^1\, l^1$ will be without effect because l^1 is free.

By this change of the fork *m n* we thus obtain the movement of the lock connection in one direction or the other, according to the position given the switch. It must be understood that the fork returns to its initial position when we throw back, first the lock-lever and then the switch-lever also.

Fig. 50 shows the arrangement of the locking apparatus and the switch-stop. The connecting-rod T^2 of the switch acts upon the rod *M*, while the connecting-rod T^2 of the lock works the lever *x y*, which moves around the axis *e*; the arm *x* moves the lock in either direction according to

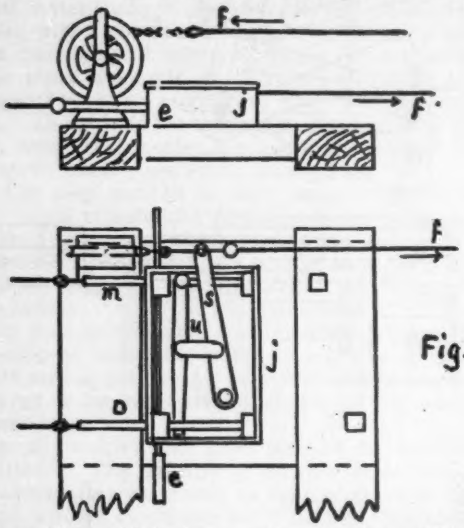


Fig. 55.

the position which the switch occupies, while the arm *v* acts through the rod *z* upon the parallelogram *r s t u* to throw back the stop *C* during the movement of the locking lever, and to restore it to place when that lever has finished its movement.

In order that the movement of *C* may be the same, no matter in which direction the connecting-rod T^2 is moved, the side *s t* of the parallelogram is cut in two around the axis *w* in such a way that, if the movement is in the direction *a*, it is the lever *r s* which turns upon the axis *w* and which moves *C*, but if, on the other hand, the movement is in the direction *b*, the axis *w* draws the lock *t u*, which is moved in the opposite direction from *r s* in such a way that *C* will work in the same manner.

As shown by the section of the lock, fig. 51, there are two parts; the lower one, v^1, enters into the slot of the cross-piece $E^1\, E^2$, fig. 50, when the movement is in the direction *a*; the upper one, v^2, corresponds to a movement in the direction *b*, while between the two there is a neutral position, which permits the movement of the switch-plate. As to the slot, it is composed of two parts, $E^1\, E^2$, shown in fig. 52, which are independent of each other, each one ending in a plate carrying similar slots. In order to produce the locking, it is necessary that these plates shall exactly cover each other—that is to say, that the two plates shall be always in the proper position, and the least disarrangement will be followed by a slight change in position, and the locking cannot be produced.

It must be admitted that this arrangement which we have described gives complete security, for it is hardly to be supposed that the connection of the lock would be broken at the same time as that of the switch. But as the double-acting lock requires a special lever, and the apparatus is somewhat costly and complicated, there are many instances in which we may use the switch-lock with a single lever, and the types which we are about to describe below are very frequently employed.

IX.—THE SAXBY & FARMER SWITCH-LOCK.

This lock is based on the same principle as that of M. Dujour, except that the locking arrangement is placed between the tracks and upon the switch-plate itself, which gives more security by doing away with the chances of disarrangement, which could be produced in the Dujour apparatus in the connection between the bolt and the switch-plate. Moreover, a special mechanism adjoining the switch permits the working of a signal of any form which may be preferred, and the giving it by a special lever a proper position in relation to that of the switch.

The advantage of this arrangement is that it can be applied, even where there are no interlocking systems, the signal and the switch-lock each having separate levers, not placed side by side.

As shown in fig. 53, the single connecting-rod *T* works, through the lever *B* on one side the switch-stop *P*, and on the other the bar *t*, joined to a lever, *a*, the latter being united on one side to the bell-crank lever *a o c*, which works the switch-bar *e*, and on the other to the lock-plate *V*. Fig. 54 shows this arrangement on a larger scale, with the levers in three different positions.

In the first part of the movement the bar is unlocked; in the second the lock *k* being drawn out of its slot, and the bolt *l* bearing against the bar *e*, the lever *a o c* causes the bar to move in such a way that the slot is presented before the bolt *l* which can then enter it; and as the switch-plates offer resistance the rest of the course of the connecting-rod is utilized to throw *l* into the slot and to lock the switch in its reversed position.

The bar *e* is extended beyond the track into a covered box, *j*, the arrangement of which is shown in fig. 55.

The double wire connection *f* (fig. 55), worked by the signal-lever, is attached to a lever *s* which acts upon the lever *u*; this last lever acts by one or the other extremity, according to the position of the switch, because one of the bars, *m n*, bears against the bar *e*, while the other enters a slot made for the purpose in this bar. It follows that it is the signal for the right-hand or the left-hand track which is moved by the lever, as may be required, an agreement being established by this arrangement between the signal and the direction given to the switch.

This system is applied chiefly to the point switches furnished, according to the English plan—used also on the Paris, Lyons & Mediterranean system in France—with semaphores which are absolute stop-signals, having two arms which are normally in a horizontal position. To authorize the passage of a train the upper arm must be lowered for the left-hand and the lower one for the right-hand track. With the arrangement shown, this result can be obtained with a single lever, and the change of signals is made by the connection between the switch and the bar.

(TO BE CONTINUED.)

PROPOSED BRIDGE OVER THE CLYDE.

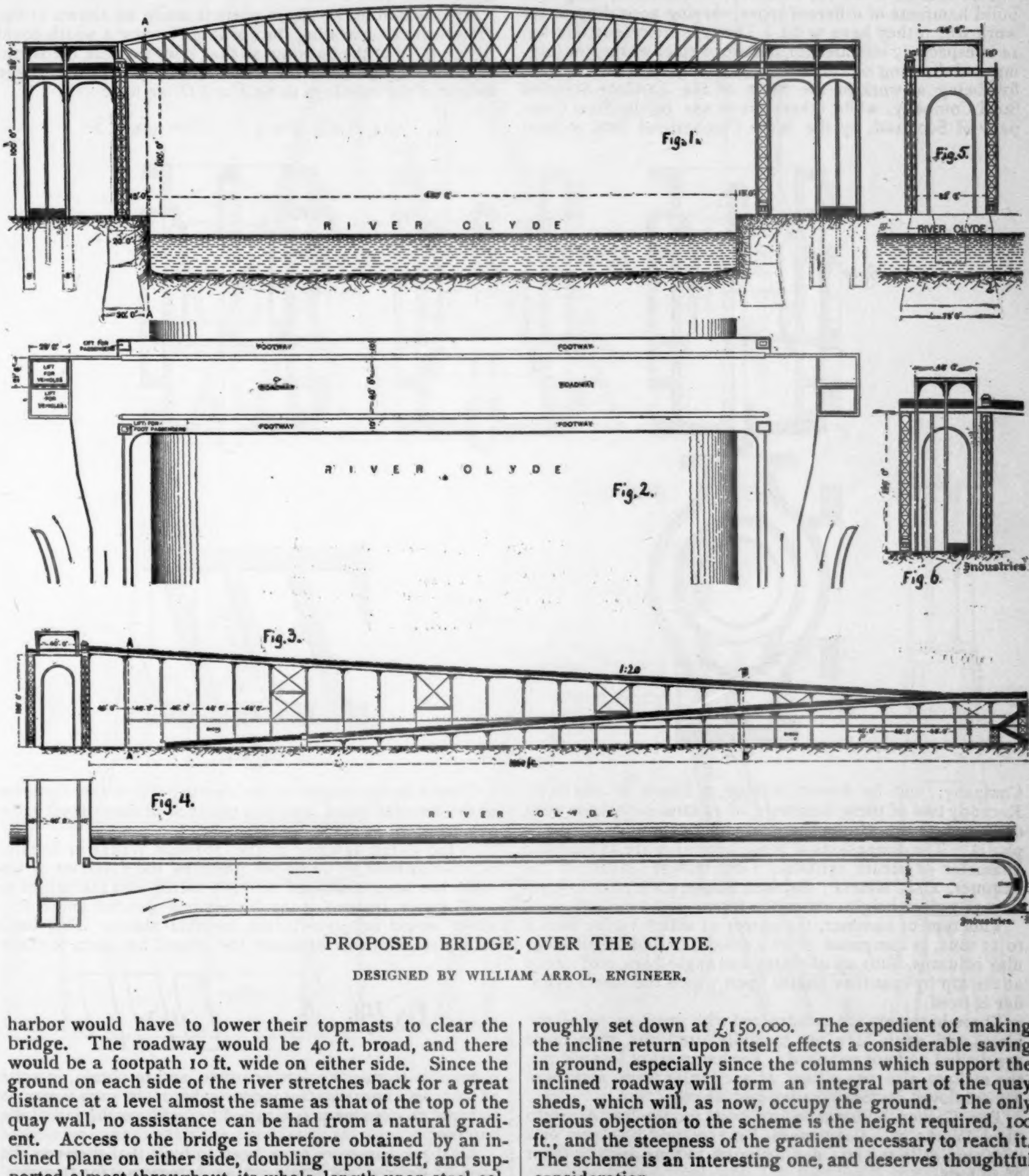
(From *Industries*.)

CROSS-RIVER communication, in cases where the rivers are used as harbors, and where the passage of steamers of considerable size has to be provided for, has been felt to be a serious difficulty in nearly all of our great ports. The Thames, the Tyne, and the Wear, with large populations on either bank, have all been bridged for large craft within their respective harbors. In the Clyde, however, the first bridge which one encounters, in sailing up the river, practically limits the harbor to the reaches of the river below it. There are a great number of cross-river ferries—swift and handy little steamers, and carrying a number of passengers quite sufficient to cope with a very large cross-river traffic. These ferries run continuously, so that there is no break in the continuity of the service. But, with the exception of the ferry at Pointhouse, they are exclusively devoted to the use of foot passengers. There is thus a distance of two miles between the bridge at one end of the harbor, and the horse ferry at the other. The inconvenience thus caused is so considerable, that for some years indefinite proposals have been made from time to time as to the expediency of providing some more convenient method of transit across the river.

A proposal of a definite character for the construction of a bridge over the Clyde at Finnieston has been made by

Mr. William Arrol, Contractor for the Forth Bridge, and has been placed before the Clyde Trustees. Among the questions involved is, of course, the question as to who should bear the cost of such a bridge ; but the interests of the Clyde Trustees in transit upon the Clyde is so great that the matter in its initial stage will at least be seriously considered by them, with a view to its erection. Mr. Arrol proposes the construction of a bridge from the north side to a point on the south side, a little to the east of the present Finnieston Ferry. The bridge would consist of a single span of 430 ft., and the roadway would be at a level of 100 ft. above the top of the quay wall, so that the largest vessels proceeding to berths in the upper reaches of the

provided two sets of hydraulic lifts. One of these sets would be used for passengers, and the other set for carts. The special feature of the design is that it affords advantages over both a swing bridge and a tunnel. In the first case traffic would be intermittent, and therefore conducted under disadvantages similar to those which already exist. In the second case, while an alteration of level, and therefore prolonged inclines, with hydraulic appliances, would be necessary, there would be the additional trouble and cost of lighting the tunnel. As against both a swing bridge and a subway, it is calculated that the proposed high level bridge would be much cheaper, both in first cost and in maintenance ; indeed, the estimate for its construction is



PROPOSED BRIDGE OVER THE CLYDE.

DESIGNED BY WILLIAM ARROL, ENGINEER.

harbor would have to lower their topmasts to clear the bridge. The roadway would be 40 ft. broad, and there would be a footpath 10 ft. wide on either side. Since the ground on each side of the river stretches back for a great distance at a level almost the same as that of the top of the quay wall, no assistance can be had from a natural gradient. Access to the bridge is therefore obtained by an inclined plane on either side, doubling upon itself, and supported almost throughout its whole length upon steel columns. With the exception of some brick-work at the lower end of the incline, the whole structure would be of steel. In addition to this roadway thus approached by an incline 2,000 ft. long, with a gradient of 1 in 20, there would be

roughly set down at £150,000. The expedient of making the incline return upon itself effects a considerable saving in ground, especially since the columns which support the inclined roadway will form an integral part of the quay sheds, which will, as now, occupy the ground. The only serious objection to the scheme is the height required, 100 ft., and the steepness of the gradient necessary to reach it. The scheme is an interesting one, and deserves thoughtful consideration.

In the accompanying illustrations, fig. 1 is an elevation of the bridge ; fig. 2 is a plan ; fig. 3 is an elevation, and fig. 4 a plan of the approaches, while figs. 5 and 6 are sections at different points.

NOTES ON STEAM HAMMERS.

By C. Chomienne, Engineer.

(Translated from the French, under special arrangement with the Author, by Frederick Hobart.)

(*Continued from page* 66.)

CHAPTER XXXV.

THE THWAITES DOUBLE-ACTING HAMMER.

THE firm of Thwaites Brothers, in Bradford, England, build hammers of different types, varying according to the work which they have to do. The type represented in fig. 14 is especially intended for the use of steel-works, for forging and drawing out ingots; it is widely used in England, five being at work in the mills of the Landore-Siemens Steel Company, while others are in use by the Steel Company of Scotland, by the West Cumberland Iron & Steel Company, and by Brown, Bayley & Dixon in Sheffield. Recently two of these hammers, of 15 tons each, have been delivered to the Union Company at Dortmund, in Westphalia. The dimensions of these hammers are as follows: Diameter of steam cylinder, 1.060 meters; stroke of the hammer, 2.745 meters; distance between the pillars, 5.000 meters; clear height under the frame, 2.360 meters.

This type of hammer, the power of which varies from 8 to 15 tons, is composed of two pillars, or hollow rectangular columns, built up of plates and angle-bars, and joined at the top by cast-iron guides upon which the steam cylinder is fixed.

These hammers are constructed with great care; all the plates and angle-bars are carefully fitted, the rivet holes are drilled and not punched. For hammers of less weight, the makers also use pillars of a circular form, and these are employed in forging tires and wheels.

The Cockerill Company has built for the Northeastern Steel Works at Valenciennes, France, two hammers of a type similar to the last, one being of 10 tons and the other of 15 tons.

This arrangement, when the pillars are set well apart, gives the hammerman an opportunity of working very freely around the anvil. It may be noted also that the 50-ton hammer at Perm, Russia, is of the same type of construction.

For hammers intended exclusively for forging, MM. Thwaites use also the arrangements shown in figs. 15 and 16; these hammers, one of 5 tons and the other of 10 tons, have been made for the Wendel Forge at Hayange; the John Brown Works at Sheffield also have several 20-ton hammers of similar type.

In all, the double-acting hammers built by Thwaites Brothers, the ratio between the weight of the striking mass alone—without counting the steam pressure acting upon the piston—and the weight of the anvil-block, is 1 : 10. We believe that this ratio is too small, and that it should not be less than 1 : 12.

In these hammers steam is distributed by means of a circular balanced valve, similar to the method shown in figs. 29, 30, and 31.

The section of the steam ports is made as shown in fig. 118, the bars separating the openings having a width equal to one-third of the opening, so that if we suppose the steam to pass through with the same speed as before and the height of the openings to be $h = \frac{1}{9} D$, we have

$$3.14\, D \times \tfrac{1}{9}\, D = \tfrac{4}{3}\, S \therefore D = \sqrt{3.82\, S}.$$

Fig. 29

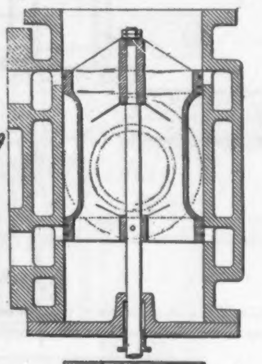


Fig. 30

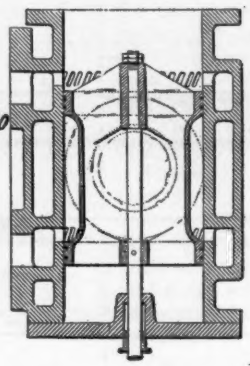
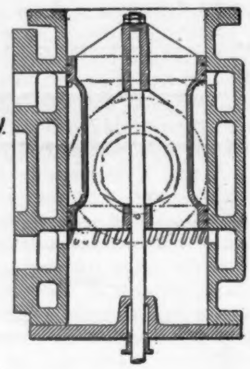


Fig. 31.



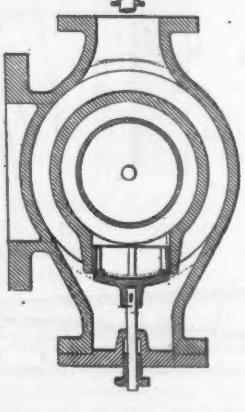
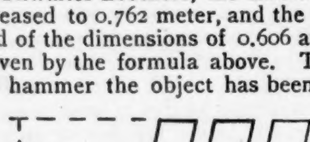


Fig. 32.

Here h is the height of the opening; D is the diameter of the circular valve, and S is the area of the exhaust valve of a hammer of the same force.

In the 50-ton hammer at the Obookoff Works in Russia, which was built by Thwaites Brothers, the diameter of the valve has been increased to 0.762 meter, and the height to 0.088 meter, instead of the dimensions of 0.606 and 0.067, which would be given by the formula above. This indicates that with this hammer the object has been to make

Fig. 118.



it possible to run at a low pressure, and to obtain, in spite of that, an almost instantaneous exhaust, in such a way as to avoid all counter-pressure and to facilitate the fall of the hammer.

All these hammers have been so built that they can be used, if desired, as single-acting hammers; for that purpose all that is necessary is to diminish the travel of the circular valve in such a way that it will not uncover the port admitting steam to the cylinder above the piston.

To raise the hammer to its full stroke the valve should be moved until it occupies the position shown in fig. 30,

when steam enters under the piston and raises the hammer, while the upper part of the cylinder is in communication with the exhaust. To permit the hammer to descend the piston should be moved until it occupies the position shown in fig. 31, when the steam acts upon the upper side of the piston, and the lower part of the cylinder in its turn communicates with the exhaust. When the valve occupies the position shown in fig. 29 the hammer is at rest, and steam cannot enter the cylinder or act upon either face of the piston.

The general custom is to open the port wide when the steam acts on the lower face of the piston, raising the hammer, and to give only a half opening when the steam acts upon the upper face of the piston.

All hammers used for making large forgings have the valves worked by hand.

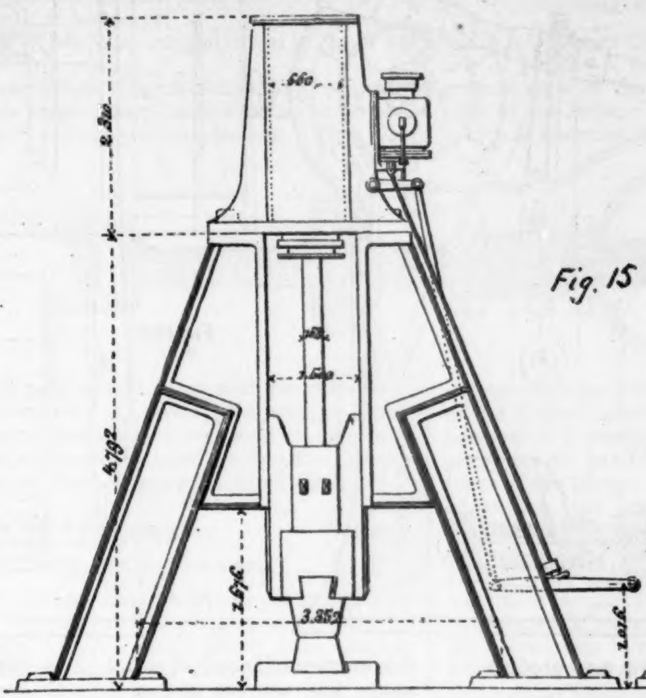


Fig. 15

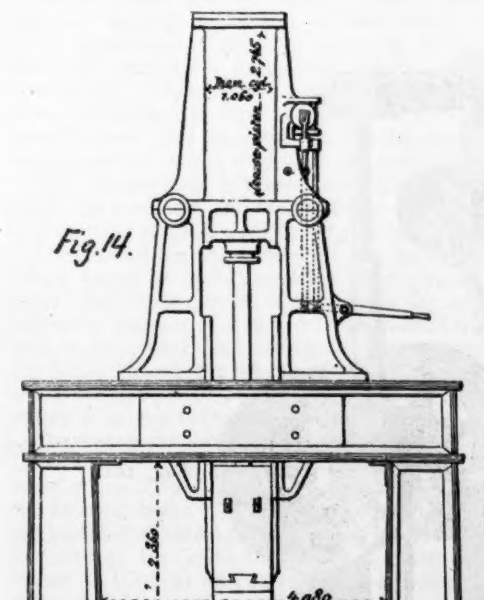


Fig. 14.

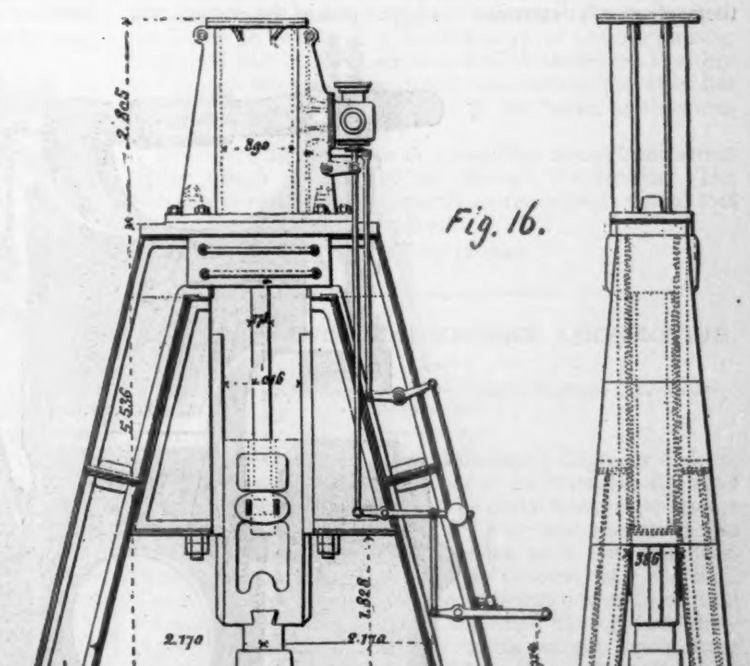


Fig. 16.

CHAPTER XXXVI.

GENERAL REMARKS ON DOUBLE-ACTING HAMMERS.

Hammers up to 500 kilogrammes should be so made as to work either automatically or by hand; for small hammers, used to forge pieces requiring rapid and uniform blows, the automatic working is very useful, but for more powerful hammers, in which the changing or moving of the pieces on the anvil requires a certain time, and which, consequently, are not required to act very swiftly, the hand working is sufficient, and the automatic working can be dispensed with.

Quickness of movement is especially desirable in working steel and in forging small pieces, which ought to be drawn into shape at a single heat.

In automatic hammers the admission of steam to raise

the hammer should always be regulated in such a way that it never precedes the blow; if not, there will be a thin cushion of steam which will produce counter-pressure, and will take away something from the force of the blow. It is necessary, in fact, that there should be a slight delay in

In double-acting hammers we can at any moment modify by hand, or even suppress entirely, the automatic motion; in the same way we ought to be able to make the force of the blow entirely independent of the speed, in such a way, for example, that the hammer can be run at

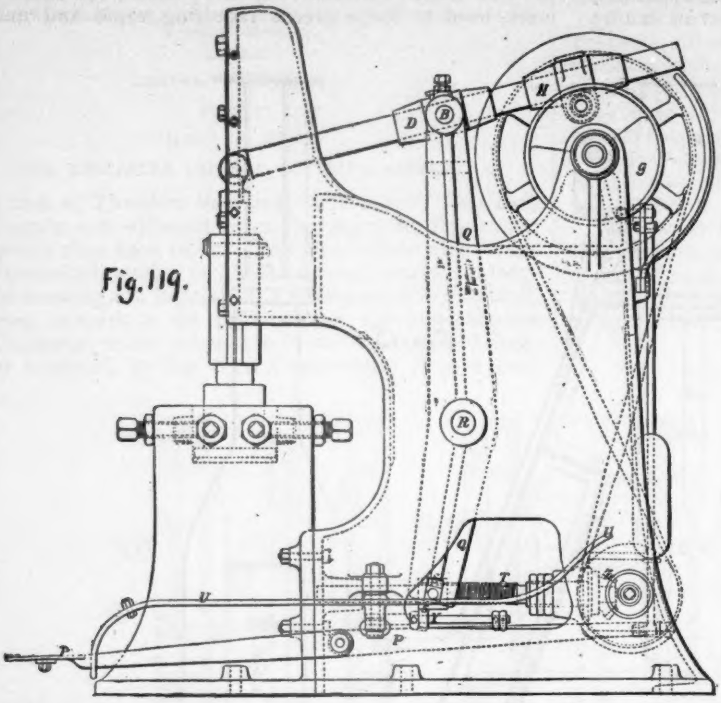


Fig. 119.

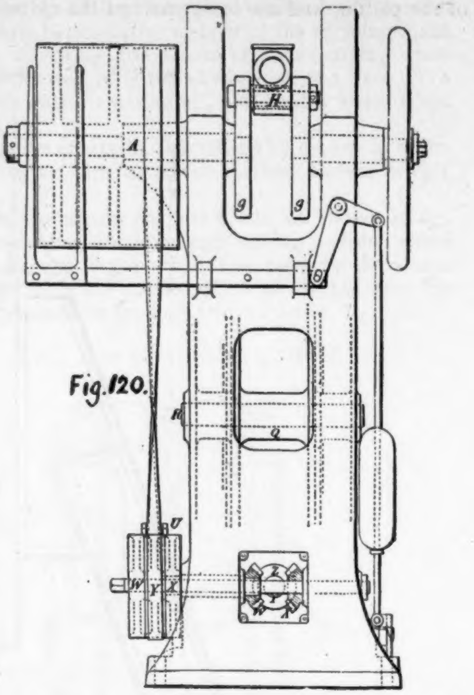


Fig. 120.

the admission of steam, so that the blow may produce its full effect.

Hammers should be arranged in such a way that they themselves will determine the upper end of the stroke, and

the maximum speed of which it is capable, while at the same time we can give a light or heavy blow at will, according to the nature of the work which is being done.

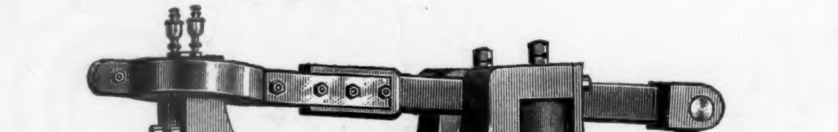


Fig. 121.

will by their own motion stop the ascending stroke; this is, in fact, an indispensable precaution, if we wish to utilize the full effect of the fall of the striking mass, without being subject to the possibility of accidents.

The use of steam, which is very small in comparison to the work done under ordinary conditions, becomes much greater when we are not able to utliize the force of the fall of the hammer—that is, of gravity; this results from the

large space above the piston, and which is filled usually with steam at each blow.

In the construction of these hammers we should always seek to realize the conditions given below.

1. Solidity in all the parts composing the machine.
2. To keep down the number of parts as small as possible, and to give them simple forms.
3. To make the hammer so that parts can easily be replaced in case of wear or breakage.
4. To give the anvil-block a weight equal to 12 or 15 times that of the striking mass.

Under favorable conditions these double-acting hammers are economical in one respect, as a hammerman can do two or three times as much work as without this tool. They also produce economy in fuel, as compared with hand-forging, as fewer heats are required; moreover, pieces forged under the hammer are much more exact and nearer the proper dimensions than those forged by hand, so that the expense for fitting and finishing such forgings is much less.

CHAPTER XXXVII.

THE PLAYER SPRING HAMMER.

Figs. 119 and 120 show a helve-hammer constructed by W. & J. Player, of Birmingham, England, and intended for making die-forgings, swaging and tilting bars, plating edge-tools, and similar work. In a hammer of the size shown the hammer-head itself weighs 112 lbs.; the stroke varies from 4 in. to 14 in., and it can be run up as high as 200 blows per minute; the compressed-air space between the main piston and the hammer-head is sufficiently long to admit forgings up to 3 in. in thickness.

The operations of starting, stopping, and regulating the blow are completely under the control of the workman through his foot, which is placed upon the lever *P*. The movable fulcrum *B*, figs. 119 and 120, consists of two adjustable steel pins attached to the fulcrum lever *Q*, and turned conical where they fit in the socket *D*.

The fulcrum lever is pivoted on a pin *R* fixed in the framing of the machine, and is connected at its lower extremity to the nut *S* in gear with the regulating screw *T*.

The to-and-fro movement of the fulcrum lever *Q*, by which heavy or light blows are given by the hammer, is placed under the control of the foot of the workman, in the following manner: *U* is a double-ended forked lever pivoted in the center, and having one end embracing the starting pedal *P*, and the other end the small belt, which connects the fast pulley on the driving shaft *A* with the loose pulley *Y* or the reversing pulleys *W* and *X*.

These are respectively connected with the lever wheels *W* and *X*, gearing into and placed at opposite sides of the bevel wheel *Z*, on the regulating screw in connection with the fulcrum lever. When the workman places his foot on the pedal *P* to start the hammer, he finds his foot within the fork of the lever *U*, and by slightly turning his foot round on his heel he can readily move the forked lever to right or left, so shifting the small belt on to either of the reversing pulleys *W* and *X*, and causing the regulating screw *T* to revolve in either direction.

The fulcrum lever is thus caused to move backward and forward to give light or heavy blows.

By moving the forked lever into mid-position, the small belt is shifted into its usual place on the loose pulley *Y*, and the fulcrum remains at rest.

To fix the lightest and heaviest blows required for each kind of work, adjustable stops are provided, and are mounted on a rod *V* connected to an arm of the forked lever.

When the nut of the regulating screw comes in contact with either of the stops, the forked lever is forced into mid-position, in spite of the pressure of the foot of the workman, and thus further movement of the fulcrum lever, in the direction which it was taking, is prevented.

The movable fulcrum can also be adjusted by hand to any required blow, when the hammer is stopped, by means of a handle in connection with the regulating screw.

CHAPTER XXXVIII.

THE DUNCAN HELVE-HAMMER.

Fig. 121 shows the Duncan helve-hammer, made by the firm of Jenkins & Lingle, at Bellefonte, Pa. Fig. 121 is a general view of the hammer, while fig. 122 shows another view of the helve.

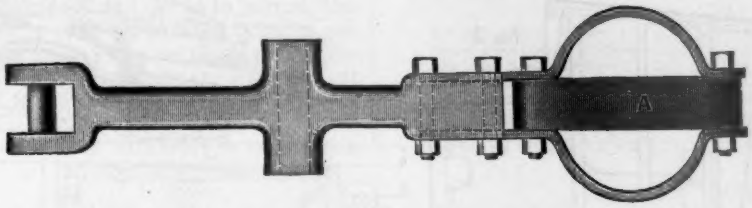


Fig. 122.

In this hammer, which is intended for die-forging, working small pieces and similar purposes—very much the same as the Player hammer above described—the main portion consists of a cast-iron frame of neat and substantial form, carrying an anvil-block sufficiently heavy to take up the force of the blow. By means of the treadle, shown in the engraving, the blow can be regulated to any desired strength, up to the full capacity of the ram. The ram, or hammer-head, being held in vertical slides, always strikes in the same place, making it desirable for die-forging. The blow is cushioned by means of four rubber cushions, two placed below and two above the fulcrum bearing of the helve; this fulcrum is made in the form of a crosshead, to which the helve is pivoted; this crosshead being free to move up or down as the strain comes on the helve.

The tension of these cushions can be regulated by means of bolts passing through them. The ram is connected to the helve by means of a flexible strap of leather passing through a bolt in its upper end, and is connected at either end to pins passing through two semicircular pieces of flat spring steel, these being bolted to the helve, as shown in fig. 122.

The force of the blow is controlled through the stress pulley, which is operated on through the treadle. The hammer is run by a belt, and is an exceedingly useful tool for small forgings and die-work.

(TO BE CONTINUED.)

A FOUR-CYLINDER COMPOUND LOCOMOTIVE.

(Condensed from Memoir of M. du Bousquet in the *Revue Generale des Chemins de Fer.*)

SOME time since M. G. du Bousquet, Engineer and Inspector-General of Motive Power of the Northern Railroad of France, was commissioned to make some experiments with the compound locomotive. For this purpose it was decided to adopt the Woolf system, with four cylinders, the cylinders arranged in pairs, or tandem, as it is called. The locomotive selected for the trial was one of those used for working the coal traffic of the road, having four driving-wheels coupled, with the entire weight upon those wheels. The dimensions of this engine before alteration were as follows:

Diameter of cylinders	0.500 meter.
Stroke	0.650 meter.
Diameter of driving-wheels	1.300 meters.
Total weight of engine	44.700 tons.
Grate surface	2.08 sq. meters.
Heating surface, fire-box	9.20 sq. meters.
Heating surface, tubes	116.78 sq. meters.
Heating surface, total	125.98 sq. meters.

The alterations, which were made in the shops of the Company at Hellemmes, consisted in the substitution of new cylinders for the old ones, with the necessary modifi-

cations in the guides and valve motion. In consequence of the greater length of the cylinder casting for the compound cylinder a slight lengthening of the frame is necessary, 0.545 meter being the addition. The compound cylinders—high and low pressure—were cast in a single piece, the intermediate head being riveted in. The small cylinder projecting backward beyond the tire of the first wheel, it was necessary to cut the cylinder-head at the side, as shown in the accompanying illustrations.

In these drawings fig. 1 is a section of the cylinders and steam-chest; fig. 2 a side view or elevation of the cylinder casting; figs. 3 and 4 show the crosshead; fig. 5 is a view

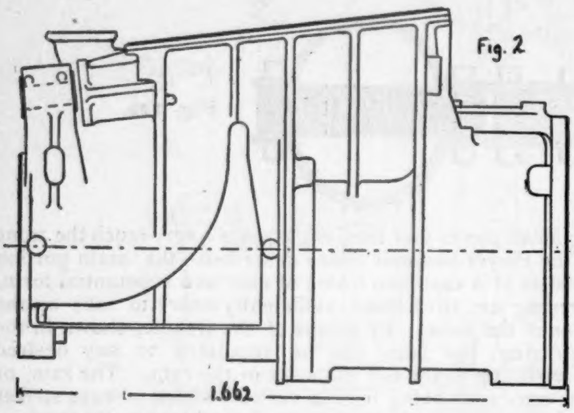


Fig. 2

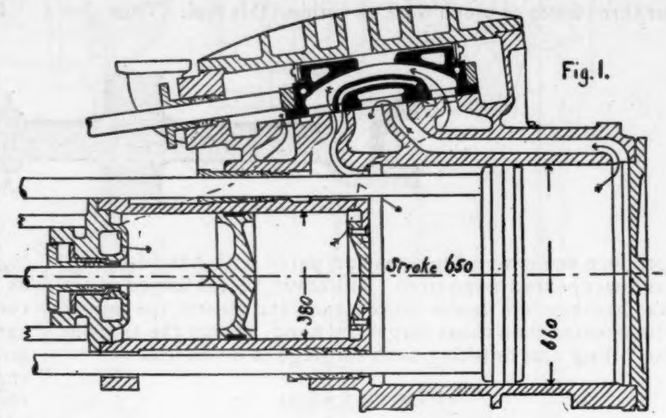


Fig. 1.

of the back cylinder head, showing the arrangement of the guides and the stuffing boxes, while fig. 6 is a sketch of the locomotive, showing its general arrangement. The valve gear used is the link motion with the solid link, which is very commonly used in France.

The steam-chest is placed above the two cylinders, as shown in fig. 1; there is a single valve moving on a valve face having five ports. The two outside ports communicate with the high-pressure or small cylinder; the two intermediate with the low-pressure or large cylinder, while the central port is the exhaust. The exhaust port is in the

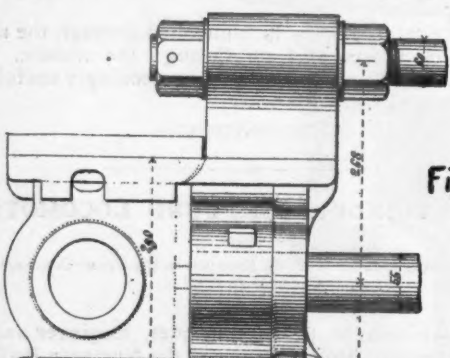


Fig. 4

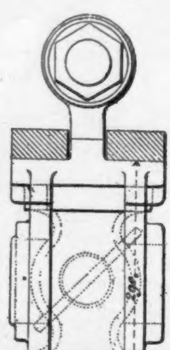


Fig. 3.

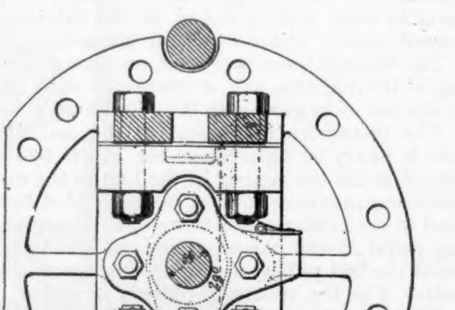


Fig. 5

same position with relation to the frame as that of the old cylinder.

The valve is made with a second passage, as shown in fig. 1, through which the exhaust from the small cylinder passes into the large cylinder at one end or the other, according to the position of the valve. This passage is, in fact, the intermediate reservoir for the steam. Its area is 16.5 per cent. of that of the small cylinder.

The passages which conduct the steam from the valve-chest to the small cylinder are longer than usual, and in this way the necessary enlargement of the free spaces of that cylinder is obtained by the position of the steam-chest; they have, in fact, been increased to 16.4 per cent. of its area. The two useless spaces of the large cylinder can thus be made very small; the back space is small in any event, while the forward space can be diminished by moving the steam-chest slightly forward of the center. In this engine the area of these spaces was 7 per cent. of that of the cylinder.

The size adopted for the compound cylinders was 0.380 meter diameter for the small, and 0.660 meter for the large cylinder, the stroke remaining 0.650 meter. The ports of both cylinders have the same length, 0.044 meter. A small opening of the valve gives a sufficient area for the admission of steam to the small cylinder, while for the large cylinder the valve adopted gives really a double opening.

The valve, which is of bronze, has a rectangular form on the face, but above it is cylindrical, and a groove turned in the cylindrical part receives two segments of cast iron. A ring of cast iron carefully bored out is placed upon these segments which form a sort of piston; this piston is held in place by the pressure of steam and by four springs which are placed on the upper surface of the rings, which, while leaving it free to turn, give it a constant bearing against the steam-chest cover. The pressure of the steam contained in the steam chest is then only felt on the rectangular surface of the base of the valve, which is diminished, of course, by the interior surface of the ring, which is 0.480 meter in diameter. Pressure on the valve is thus very light, and is, in fact, insufficient to hold it in place when the central part is in communication, as in an ordinary valve, with the air. For this reason it was found desirable to put this part in communication with the steam held in the intermediate passage by drilling a small hole in the upper part. In practice it was found that, in spite of the large dimensions of the valve—0.605 × 0.520 meter—the friction between the valve and the valve-seat could be diminished as

much as desired. It may be noted that any slight leakage of steam around the ring would be of no importance, as the steam would pass directly into the large cylinder.

The piston of the large cylinder is of cast iron, with the ordinary packing rings, and has two rods placed far enough apart to pass one on each side of the small cylinder. In this way any use of interior stuffing-boxes is avoided.

The small piston is of wrought iron forged in one piece with the rod. The three rods are connected with the same crosshead, which is of cast steel; the central rod—that of the small cylinder—being held by a key, the two others fitting in taper holes and held in place by two nuts, as shown in figs. 3 and 4.

The guides, which are of steel, are made double on account of the form of the crosshead, so as to permit the arms to which the two piston rods of the large cylinder are attached to pass through them. They are supported at the back end by a yoke or brace in the ordinary way, and at the front end are bolted to lugs cast on the back cylinder head, as shown in fig. 5.

It will be seen that when it is necessary to take down the pistons, that of the small cylinder must be taken out from the back, and that of the large cylinder from the front.

In this arrangement it will be seen that the breakage of the intermediate head would have serious consequences. Such a breakage might be produced by the breaking of the small piston-rod or by the breaking of the connecting-rod. In order to avoid the first case, it is important to make the piston-rod large enough; it may also be remarked that even if it should break, the small piston would not strike the cylinder head with the same force as in an ordinary locomotive, first because the counter-pressure is considerable, and, second, because the steam exhausts into the confined space of the large cylinder, and not freely into the air. The second case is more to be feared, but the remedy is easy: it is to leave more clearance before the small piston at the end of its stroke than before the large one; the large piston would then strike first and the front head of the cylinder would receive the main shock. It is also possible to adopt an arrangement by which the crosshead would strike the end of the guides before the piston would strike the head.

The exhaust used is the ordinary variable exhaust employed on this class of engines. The only change is that the blast-pipe is somewhat larger, the section having been increased from 229 to 308 sq. cm., the steam being more expanded and requiring a greater space; moreover, the right and left-hand exhaust are separated by a partition which is carried up nearly to the head of the blast-pipe. This arrangement has been found to work very well, and steam-pressure is easily kept up in the boiler, even during long stops.

It may be noted that in order to diminish resistance when steam was shut off while the locomotive was in motion, to avoid heating and to prevent the drawing of gas and cinders into the cylinders, a small valve was placed on the steam-chest cover by which air could be admitted. This was easily worked, and was found to give very good results.

The increased weight of the new cylinders threw too great a proportion of the weight on the forward drivers; this was remedied by using a heavy cast-iron foot-plate at the rear of the engine; this weighed 3,000 kilos. The total weight of the machine was increased by 7,000 kilos., its weight after alteration being 51.700 tons.

The weight of the engine and its distribution, before and after alteration, was as follows in tons:

	As Altered.	Old Weight.
On first pair of drivers	13.460	12.200
On second pair of drivers	14.240	11.100
On third pair of drivers	13.980	12.100
On fourth pair of drivers	10.020	9.300
Total, tons	51.700	44.700

A special steam-valve 3 cm. in diameter, placed behind the throttle-valve, permits steam to be admitted directly into the large cylinder. The pipe which conducts steam from this valve passes through the center of the valve-seat and communicates with the passage which forms the reservoir between the two cylinders. In this way steam can, if desired, be admitted directly to the large cylinders, but in practice this is not found necessary either in switching or in ordinary running on heavy grades; it would be, moreover, unfavorable to the proper utilization of the expansive force of the steam.

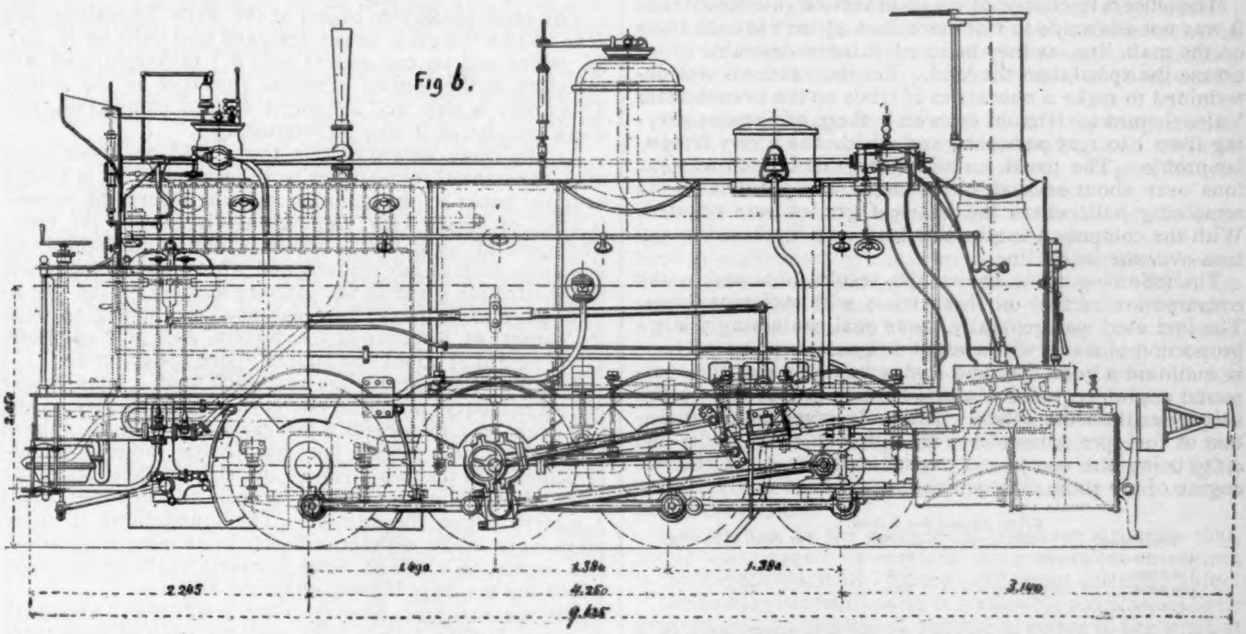
This special admission of steam, however, is useful in case of a chance stoppage on a heavy grade, as it permits the starting of the train with all couplings in tension, and without a jerk. It will be seen that under these conditions breakages of couplings are much less to be feared.

Each double cylinder is furnished with four cylinder-cocks to discharge condensed water, the same as in an ordinary cylinder.

It is important in compound engines to take some precautions to avoid a useless waste of oil. In the engine described the only additional lubrication required was for the piston of the large cylinders. For this purpose the Consolin oiler was used, by which the steam is charged with oil on its passage from the valve, no attempt being made to lubricate the parts separately.

The first trials of this engine were made upon the main line of the road, where it was put into service hauling coal trains, and where its work was compared with that of other engines of the same class with the ordinary simple cylinders. The usual load of these trains was 675 tons, or 45 coal cars; with the compound engine this load was in-

Fig 6.



creased to 60 cars or 900 tons. The trip made was from Lens to Longueau, and return, 170 kilometers. This trial was made during the month of January, when the conditions are usually most unfavorable to traction. The starting from Lens was always made without trouble, although somewhat difficult, since the start from the yard tracks is on a grade of 1 per cent., and over a very sharp curve, and a train enters immediately upon a grade of 0.5 per cent., 10 kilometers in length.

On certain trips the engine ran through to La Chapelle; on one of them the load of 900 tons was taken from the station at La Chapelle to the coal switches there over a grade of 1.5 per cent., 600 meters long, at the foot of which the train had to be started. To get over this difficult point it was necessary to use the direct admission of steam to the large cylinders; diagrams taken, however, with this admission showed that, owing to the small opening of the valve, 3 cm., there was not the full boiler pressure upon the large pistons, and that, consequently, the strain upon the working parts was not too great. It was found that the boiler was sufficient to supply all the steam needed.

The officers in charge of the train service considered that it was not advisable to run more than 45 cars to each train on the main line, as they believed it more desirable to increase the speed than the load. For this reason it was determined to make a new series of trials on the branch from Valenciennes to Hirson, on which there are grades varying from 1 to 1.25 per cent., and which has a very irregular profile. The usual train-load on this branch was 422 tons over about one-half of its length, and 387 tons on the remaining half, where the heaviest grades were situated. With the compound engine this load was increased to 540 tons over the whole line.

The following table shows the results obtained in the consumption of fuel on these trials with different loads. The fuel used was generally waste coal containing a large proportion of slack, with enough briquettes (prepared fuel) to maintain a good fire, and it may be noted that the compound engine required a much smaller proportion of the briquettes than the other. The table gives the consumption of fuel per kilometer with different train-loads, No. 4,729 being the compound engine, and No. 4,728 another engine of the same class which has not been altered:

Train-load.	Kilog. burned per Kilom. No. 4,729.	No. 4,728.	Per cent. of Saving.
400 tons	17.3	20.0	13.5
450 tons	26.5	20.0	24.5
500 tons	25.2	19.6	22.4
540 tons	35.2	27.0	23.6

After this series of trials the two engines with which they were made were put, in July 1888, in ordinary service between Fives and Hirson, hauling the same trains on alternate days. The station agents had orders to put a load of 522 tons on the compound engine and 462 tons on the other, these loads being calculated on the limit of adhesion. The table below gives the results obtained in the consumption of fuel per kilometer, No. 4,729 as before being the compound engine, and No. 4,728 the other; this trial was extended over two months, and the results are averaged for each month:

Month.	Kilog. burned per Kilom. No. 4,729.	No. 4,728.	Per cent. of Saving.
July	13.81	15.86	12.9
August	14.18	15.94	11.0

It will be seen that in this case the saving in fuel, in spite of the increase of 13 per cent. in the load, was from 11 to 13 per cent., while the expense of lubrication was less for the compound engine than for the other. If the load be taken into account, the saving in fuel per kilometer-ton was from 27.2 to 21.1 per cent.

During these trials a great number of indicator diagrams were taken from both engines. Space will not permit us to reproduce these diagrams, many of which are given in the memoir of M. du Bousquet, but his general statement of the results is that they approached very nearly to the theoretic diagrams, which he had constructed while studying the question before undertaking the actual experiments, and that the calculations which he had then made were confirmed by experience in a very remarkable way. His general conclusions on this engine may be summed up as follows:

The compound engine draws, on lines of high grade, loads 12 per cent. greater than the ordinary engine of the same class, while securing a considerable economy in fuel, and not increasing the cost of lubrication.

The point which remains to be determined is whether the expense of repairs and maintenance will be increased. This question must be studied and tested by the continued service of the engine, because a short trial is not sufficient, and because also it would not be fair to take account of the minor points in which alteration may be found necessary or of mistakes resulting from the uncertainties always attending a first trial.

It may be said, however, with certainty, that there will be no trouble with the valves, and that they will not require more attention than the valves of the ordinary simple cylinder.

THE EIFFEL TOWER IN PARIS.

THE most prominent object at the Paris Exposition this year will be the great tower designed and built by M. Eiffel, which will be 300 meters (984 ft.) in height, and will therefore be the loftiest artificial structure in the world. This tower is now well advanced toward completion, and some account of it may be interesting.

As the total weight of this tower will be about 9,000 tons, substantial foundations were necessary. It is placed near the banks of the Seine, at a point where the subsoil is a bed of plastic clay, sloping rapidly toward the river. The general form of the tower, which is probably well known to most of our readers, and which may be seen from the illustration given in the January number of the JOURNAL, page 12, is that of four legs or pillars springing from the corners of a square of 100 meters, and uniting in one at the height of about 100 meters above the ground.

The four metallic towers rest each upon a huge pile or pier of masonry, placed at one corner of the square. The first step was to ascertain the exact nature of the subsoil by frequent and careful borings. From these it was ascertained that the two piers on the side farthest from the river could rest upon the solid subsoil at a depth of about 7 meters below the surface. The foundations to these piers were made without difficulty in an open excavation, and consist of a bed of beton 2 meters in thickness, upon which the masonry is built up to the surface.

For the two piers near the river it was found necessary to make further foundations, and for each of them there were sunk four caissons, each 6 × 15 meters, of wrought iron; these were sunk 12 meters below the surface, and 5 meters below the water-level, resting upon the hardpan, which is here a very coarse gravel and very compact.

The piers have the form of a pyramid, the two inner faces being straight, while the two outer faces are inclined in the same directions as the pillars in the tower. In one of the piers there has been made a room, in which will be placed the engine running the elevators and other machinery.

Each pier has a top of heavy cut-stone masonry, upon which is placed a large shoe, or socket, of cast iron, weighing about 6,000 kilogrammes, which is fastened to the masonry by two anchor-bolts 7.80 meters in length and 0.10 meter in diameter. The service of these bolts, however, is temporary only, as the weight of the tower when finished will be quite sufficient to hold them in place without any anchorage.

These shoes receive directly the four uprights or girders which are the main members of each branch of the tower. These girders are built up of plates and angle-irons riveted together, the different sections being entirely fitted in the workshop so that they can be put together without delay. The cross-bracing and connections between the main girders are put on for each section as it is put in place.

The erection of each of the legs was made by the aid of wooden false-work until it reached the height of 26 meters. At this point a change was necessary, for the reason that the inclination of the members would have carried their center of gravity outside the base of the tower, and the further progress of the work would have resulted in its fall.

At this point, therefore, heavy scaffoldings of wood are put up, having the form of triangular pyramids, with the apex bearing against the pillars and supporting them. These were so arranged that the erection of the towers could be continued safely.

At the height of 48 meters above the foundation, the four pillars are joined by an immense horizontal girder, 7 meters in depth and 42 meters in length on each side of the square. A difficult problem was here presented, that of putting these girders in place, without support except at the ends; it was solved by erecting in the center of each side of the square a wooden tower upon which the girder was erected, so that nothing further remained than to join its extremities to the branches of the tower.

In order to provide against any slight irregularity which might be found in the heights of the branches of the tower, there was provided upon each foundation a hydraulic press having a lifting force of 800 tons, and by this the level of the pillars could be regulated to the smallest fraction; thus the connection between the legs and the girders of the first section was made without the slightest difficulty, although, as has been said, all the sections were fitted and finished to their proper length in the workshop, only their erection being done on the ground.

The girders of the first stage being in position, a new base was presented, from which the erection of the tower could proceed, and the work here was simply a repetition of that below, the only difference being that it started from staging placed upon the girders, instead of the surface of the ground.

The hoisting and placing of the members of the different sections was performed by cranes, so arranged that they could gradually be raised as the work proceeded. In each of the four pillars there were arranged two girders intended to form a road for what might, for want of a better term, be called the hoisting cabin. In these girders there had been placed, at regular intervals, holes drilled in the flanges; the pivot cranes were placed in a small cabin, or building, in the form of a pyramid, with the base upward, serving as a platform for the workmen, while the apex held the step carrying the pivot of the crane. One face of the pyramid was arranged to correspond with the girders of the tower, and the two beams forming its upright side had holes bored in their flanges also, so that they could be bolted at any point to the girders of the frame. The platform thus fixed in place, the crane hoisted and distributed the material. When its work on that section was finished it raised itself over the section, by means of a crab of peculiar construction, and was again bolted fast in the new position. This process was repeated as often as necessary.

Four of these cranes, one for each branch of the tower, were provided; they were capable of lifting 3 tons each, and were found in practice very efficient. After reaching the top of the first stage they were continued in service, but on the girders of this stage there was placed a special hoisting machine, with an engine of 12 H.P., which raised the material from the ground to this stage, where a circular track distributed it to the four cranes. The same method, with such modifications as may be found necessary, will be continued to the summit of the tower.

The objections originally made to the tower were that the weight of such a structure would be too great for the foundations, and that it would be liable to destruction from the oscillations caused by the wind. It is claimed, however, that, owing to the adoption of iron and steel as material, the weight carried by the foundations is really less than that of some of the larger buildings in Paris, while the system of wind-bracing is so complete, and the tower has been so carefully proportioned to resist wind pressure, that the oscillation will be hardly perceptible.

To a minor objection raised, the danger to persons on the tower during thunder-storms, it is replied that the tower has been connected with the water-bearing strata of the subsoil, so that the entire structure is, in effect, a huge lightning conductor, and that the effect of the most severe shock would be so distributed as to be imperceptible at any point.

The arrangements made for sightseers during the Exposition are very complete. There will be staircases provided for visitors, but most of them will probably prefer to use the elevators. From the ground to the first stage (48 meters) there will be four elevators, one in each branch of the tower, capable of carrying 100 persons at a time. From the first to the second stage two swift elevators will be provided, each carrying 50 persons. From the second to the third or final stage there will be a single elevator capable of carrying 750 people an hour. In this last the passage will not be made from the second to the third stage in the same car, but the trip will be in two parts; that is, leaving the second stage visitors will be carried by the first elevator to a height of 196 meters, where they will pass over an intermediate platform and take a second elevator, which will carry them to the third or top stage, 277 meters above the ground. The ascent of the last stage is so divided because one of the cars serves as a counterbalance to the other, so that while one descends the other rises, and *vice versa*.

The arrangements for entertaining visitors to the tower are not yet entirely fixed, but on the first stage, which has an area of 4,200 sq. meters, there will be four restaurants, one at each angle; four large halls, each 37×15 meters; four balconies on the inside of the huge quadrilateral, and finally an exterior balcony, 3 meters in width, by passing around which a complete panoramic view of Paris can be obtained.

The second stage has an area of only 1,400 sq. meters, but will contain a restaurant and a dancing hall, while an outer balcony, like that of the first stage, will give visitors a view of Paris from a height of 151 meters.

The third stage, the highest part accessible to the public, has its floor 277 meters above the ground, and will have a surface of 370 sq. meters. This hall will be entirely covered in with glass. Above this M. Eiffel has reserved a space 10 meters square in which he will make a special room for such experiments as may be suggested by scientists. Above this room will be placed a heavy girder, which will carry the pulleys of the elevator; upon this girder will be placed a small tower, in which there will be a staircase giving access to a lantern 5 meters in height, which will be lighted by an electric light. A ball is placed on top of the lantern, and above it rises a lightning-rod, the top of the ball being exactly 300 meters above the ground.

It is claimed by the designer of this huge structure that, above and beyond its services as an attraction to visitors to the Exposition, it will have a permanent scientific value.

Meteorologists will find in it a valuable auxiliary in their experiments on the speed and the pressure of the wind at different heights above the ground; on the law of the changes of temperature with height; on the hygrometric state and the analysis of the air at different heights, and on atmospheric electricity.

Astronomers will be able to use it for the examination of the telluric rays of the sun, for photography, and for the spectroscopic examination of rays of light from the stars, which can be made under conditions not heretofore attainable, because the summit of the tower will be raised completely above the vapors arising from the earth.

In physics it can be used to verify the laws of the deviation of a falling body, and the experiments of the Foucault pendulum; also for the installation of manometers, for the study of the law governing the compression of gases, since a direct graduation can be made up to 400 atmospheres.

Physiologists will find in the tower an excellent place for the study of the air with respect to freedom from bacteria and other impurities, and also for the study of the influence of the air upon the circulation of the blood at such heights; studies on the flight of birds, etc.

Finally, from a military point of view, the tower will furnish an observatory, the value of which can hardly be appreciated, since no similar one has ever yet been provided.

Thus, it is claimed, the tower will be not a mere object of curiosity, but a structure capable of rendering signal services to the national defence and to science. Whether these claims will be justified or not, the tower is an interesting structure and commands attention from its great size alone, if for no other reason.

UNITED STATES NAVAL PROGRESS.

THE following notes show the progress of the work made in the reconstruction of the Navy, giving such occurrences of the past month as appear to be of interest.

NEW SHIPS.

The Senate Naval Committee has added to the House bill appropriations for a new steel cruiser of 2,000 tons displacement, to cost $700,000; and for two steel gunboats of not more than 1,200 tons dsplacement, to cost $700,000. The Committee has also approved the appropriation of $1,500,000 for the construction of the coast defense vessel designed by Mr. Thomas. Besides these, the bill includes appropriations of $450,000 for a new dynamite gun-boat, and $140,000 for four steam tugs. The bill, it is thought, will pass with all these appropriations.

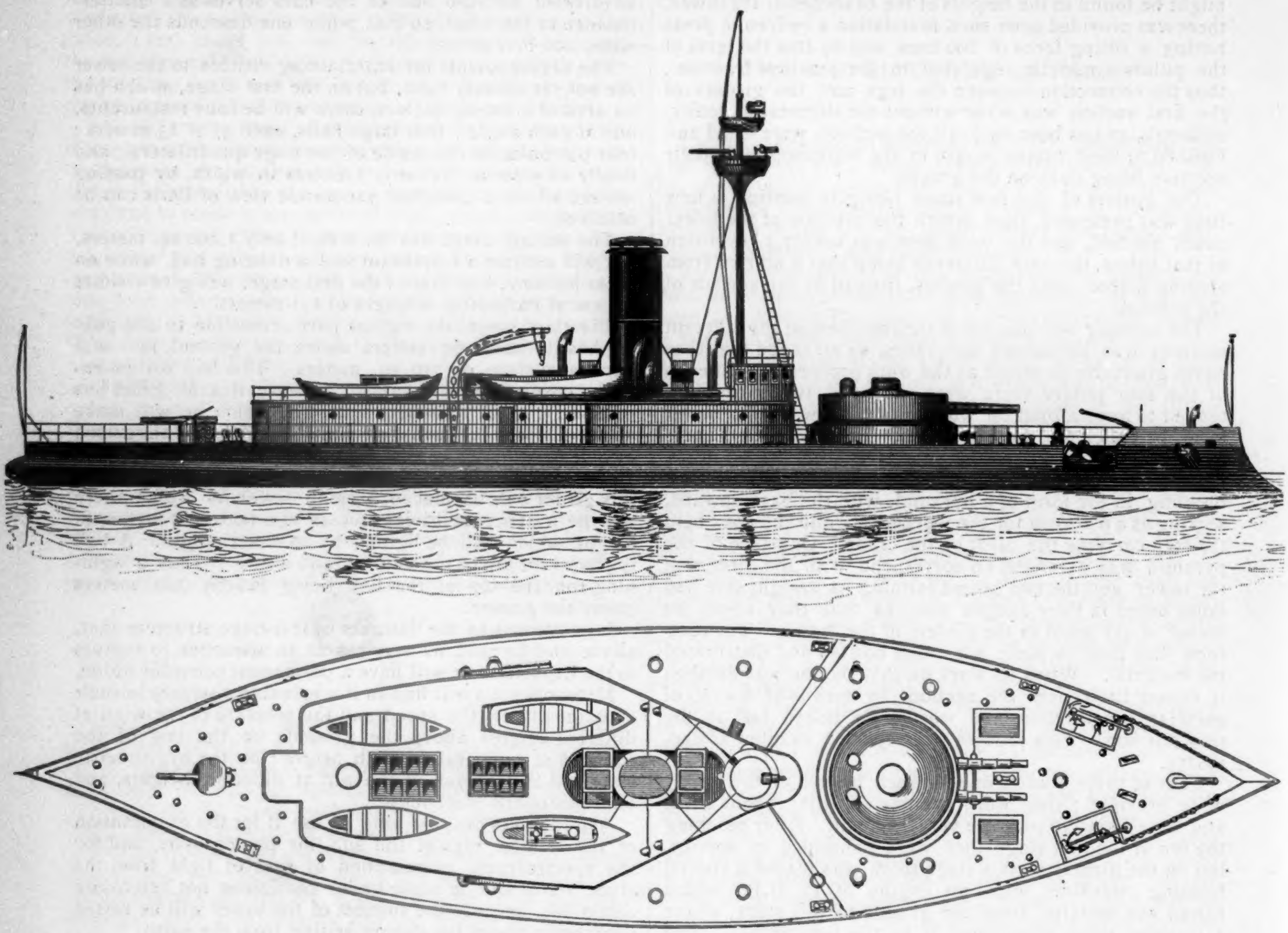
The new gun-boat *Yorktown*, having successfully passed the preliminary trial, is now undergoing a sea trial, in charge of the Board of Naval Officers.

The cruiser *Charleston*, which was built at San Francisco, will also be taken to sea for her final trial about the latter part of this month, making a trip down the coast from San Francisco, when her performance will be carefully noted.

The cruiser *Baltimore*, under construction at Cramps' yard in Philadelphia, has received her engines, and will be ready for the steam trial in about two months.

The *Philadelphia*, at the same yard, has her hull now nearly completed, and will be ready for launching in April. The hull of the *Newark* is also well advanced, and she will be ready to launch soon afterward.

Notice is given that proposals for the machinery of the new armored battle-ship *Texas* will be received at the Navy Department until noon on April 3. The proposals must include all the machinery—engines, boilers, screw propellers, shafting, pumps and all appurtenances, including appliances for working under forced draft. The machinery must be delivered complete and ready for erection on board the vessel within two years and six months from the date of the contract. The contract will contain provisions relating to premiums on penalties in connection with the development of horse power according as the same shall be above or below the required maximum. The proposals will be divided into three classes as follows: 1. For machinery in accordance with the plans and specifications provided by the Department. 2. For machinery in accordance with such plans, with modifications as proposed by the bidder. 3. For machinery in accordance with plans and specifications submitted by the bidder, such plans to conform to the weight and space provided for in the general plans of the vessel. Bids under classes 2 and 3 must be accompanied by plans and drawings sufficient to show the designs satisfactorily. Plans, specifications, and blank forms can be obtained on application to the Chief of the Bureau of Steam Engineering, Navy Department.



THE SUBMERGING MONITOR CRUISER.

A conference was held recently at the Navy Department, at which a number of steel manufacturers were present, and the regulations for the inspection of steel for the new naval vessels were discussed, but no definite action was taken and no change in the rules were ordered.

NEW GUNS.

The 6-in. gun, cast by the Standard Steel Casting Company at Thurlow, Pa., had its preliminary test at the proving ground at Annapolis, February 7. Twelve rounds

were fired, two with charges of 36 lbs. of powder and a 100-lbs. shell, and 10 with charges of 48½ lbs. of powder and 100-lbs. shells. The gun stood this test very successfully, and was reported as entirely sound after the test. It has still to undergo what is known as the endurance test.

The official trial of the large dynamite gun, which recently took place, was very successful. Nine shots in all were fired with the large 450-lbs. shell, and of these five fell within a rectangle 50 × 100 ft., as specified in the contract with the Department. The ranges varied from 2,009 to 2,177 yards.

The report of the Board has not been published, but must have been favorable, for the Secretary of War has since given out a contract to the Pneumatic Dynamite Gun Company to furnish seven dynamite guns, with the steam-power and air compressors necessary for working them, the contract price being $395,500, the guns to be delivered within eight months. Of these seven guns two 15-in. and one 8-in. are to be put at Sandy Hook, New York Harbor; two 15-in. guns at Fort Schuyler on Long Island Sound, and the remaining two 15-in. guns at Fort Warren in Boston Harbor.

THE THOMAS SUBMERGING MONITOR.

We give herewith an illustration, for which we are indebted to the *Army and Navy Register*, of this vessel, whose peculiarities have excited much attention, and we add also some particulars to the description given last month.

The principal dimensions are as follows: Length on load line, 235 ft.; extreme breadth, 55 ft.; cruising draft, 14½ ft.; displacement at cruising draft, 3,030 tons; coal supply carried, 550 tons. The engines are to work up to 7,500 H.P. with forced draft, and the extreme speed is to be 17 knots. The draft can be increased to 17½ ft. for fighting purposes, by means of tanks which can be very quickly filled. The vessel is to be strengthened by a system of longitudinal and transverse girders, and is to be provided with a formidable bow for ramming. With the engines working without forced draft, and with an average speed of 10 knots, the vessel will have a cruising range of 8,500 knots.

The character of the armament is as follows: Two 10-in. breech-loading rifles for long range, with capacity for throwing shell charged with high explosive compounds. These guns are mounted in a turret armored with 10-in. solid steel plates, the axis of the guns when level being 11 ft. above the fighting load line, with a range of fire from direct ahead to 65° abaft the beam on either side, and by removing the deck-house increasing the range to a practically all-around fire. For close quarters she has a 15-in. Zalinski dynamite gun capable of throwing 800 lbs. of high explosive compound, and two under water bow torpedo tubes, also a 6-in. rapid-firing breech-loading rifle located aft. The secondary battery consists of three 3-pounder rapid-firing and one 37-mm. revolving gun.

THE LATEST ENGLISH CRUISERS.

(From the London *Engineer*.)

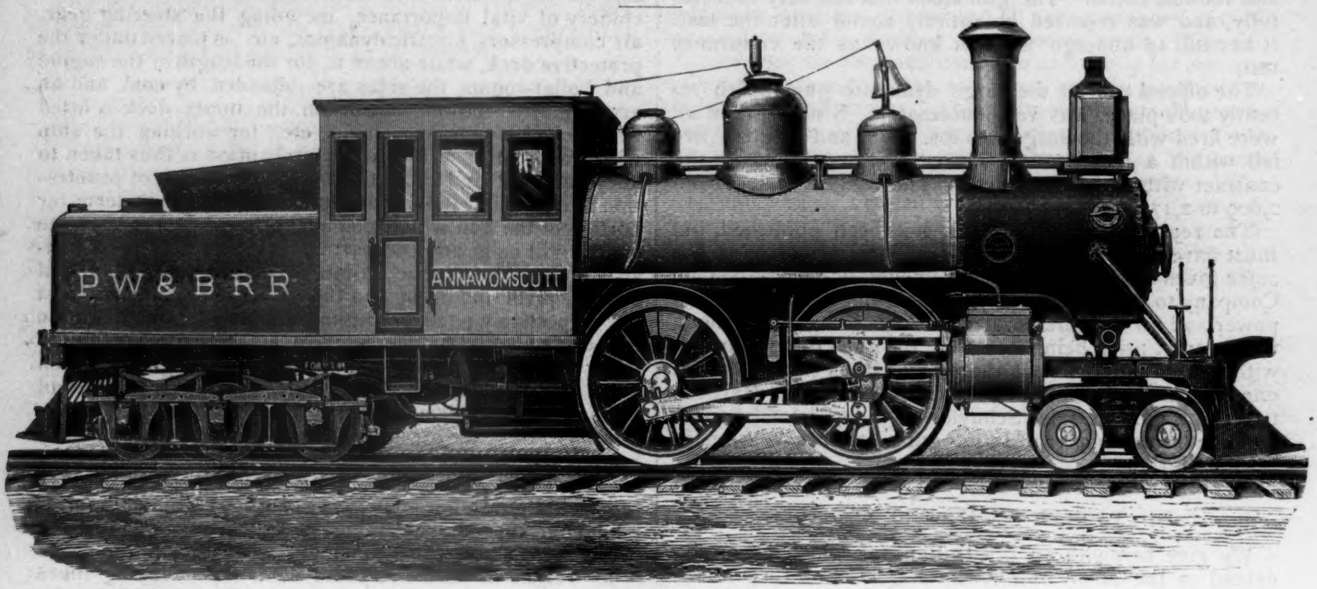
THE *Australia* and the *Galatea*, the latest additions to the Navy, built and engined by R. Napier & Sons, Glasgow, belong to the class of swift and powerfully armed belted cruisers, specially designed for the protection of commerce. Their principal dimensions are: Length between perpendiculars, 300 ft.; breadth, extreme, 56 ft.; depth, moulded, 37 ft.; with a displacement of 5,000 tons at 19 ft. draught when in the normal fighting condition, but this may be increased to 6,000 tons when an extra supply of coal is shipped. The belt which protects the water-line for two-thirds of the length consists of steel-faced compound armor 10 in. thick, strongly supported by steel and teakwood backing, and terminates at each end in an athwartship iron bulkhead 16 in. thick to stop end-on shot. Level with the top of the armor belt is a protective steel deck, 2 in. thick on the flat, and 3 in. on the angle, where it slopes down below the water-line, and this deck also extends to the stem and stern respectively. All the machinery of vital importance, including the steering gear, air compressors, electric dynamos, etc., is placed under the protective deck, while above it, for the length of the engine and boiler-rooms, the sides are defended by coal, and an armor-plated conning tower on the upper deck is fitted with steering gear, telegraphs, etc., for working the ship when in action. While every precaution is thus taken to keep out shot and shell, the buoyancy in case of penetration is insured by the minute subdivision of the underwater portion of the hull which contains upward of 130 separate water-tight cells and compartments. The armament consists of two long range 22-ton breech-loading guns and central pivot mountings on the upper deck, forward and aft respectively; ten 6-in. guns similarly mounted on the broadside; eight 6-pounder, and eight 3-pounder, quick-firing guns, also six torpedo tubes. The engines, which were designed by Mr. A. C. Kirk, the senior partner of Messrs. Napier's firm, were originally specified by the Admiralty to be of the ordinary compound type for 7,500 H.P.; but from their previous experience Messrs. Napier were able to show that by substituting triple expansion engines they could guarantee an increase of 1,000 H.P., and almost a knot more speed, thereby enormously increasing the value of the ship as a fighting machine, without adding to the total weight of machinery and coal, or occupying more space. This suggestion was eventually adopted by the Admiralty, and also carried out in the other ships of the class.

The two sets of engines are of the three-crank horizontal type, working twin screws, and are placed one before the other in separate water-tight compartments, the cylinders being 36 in., 51 in., and 77 in. in diameter and 44-in. stroke. Steam is supplied by four double-ended boilers, of the return-tube type, which are placed forward of the engines in two independent stokeholds divided by water-tight bulkheads. The results of the official trials were highly satisfactory, and fully justified the contractors' proposal to introduce the triple-expansion engines.

In the case of the *Galatea*, the collective horse-power on the four hours' forced draught trial was 9,204, being more than 700 H.P. in excess of the contract; the highest power developed during any single half-hour was 9,665 H.P., and the mean of the last three hours gave 9,415, equal to 1,915 indicated H.P. above what was originally proposed by the Admiralty. This splendid result was attained on a consumption of 1.97 lbs. of coal per indicated H.P. per hour with an air pressure in the stokeholds of only 1¼ in., and that while working as pure triple-expansion engines, without passing boiler steam into the receivers, and the steam was supplied in such abundance that with the engines working at their maximum there was a constant blow-off.

Hicks' "Centrifugal" Gun.—A very novel machine, for the discharge of dynamite projectiles, shells, and solid shot from the periphery of a rapidly-revolving wheel has been invented by Walter E. Hicks, of Brooklyn. Mr. Hicks expects an initial velocity of 2,000 ft. a second from his 10-ft. wheel, when flying at the rate of 4,000 revolutions a minute. The motive power is a steam-engine. The wheel consists of two steel disks, thin at the circumference, but quite thick at the center, standing several inches apart and firmly joined by bolts. Outside each disk is a double quadrant for the use of the gunner in training the gun at a desired elevation. Combined with each quadrant is a mechanical contrivance that, by the pulling of a lanyard, opens a clutch and releases a projectile at just the point at which the gun may be trained. Two shots at opposite sides of the wheel are thus fired, an infinitesimal fraction of a second apart. A wheel 10 ft. in diameter is required for a 6-in. shot, and for every additional inch of diameter in the shot there must be 20 in. more of diameter in the wheel according to Mr. Hicks's calculations. The entire machine, including the steam-engine, stands upon a single plate that may be placed upon a turn-table and adjusted like any marine gun-carriage. The projectile especially designed to be used in this machine is a long cigar-shaped shell, with heavy solid ends, the intervening space being occupied by camphorated nitro-gelatine surrounded by gun-cotton, as in the Zalinski projectile.

CATECHISM OF THE LOCOMOTIVE.



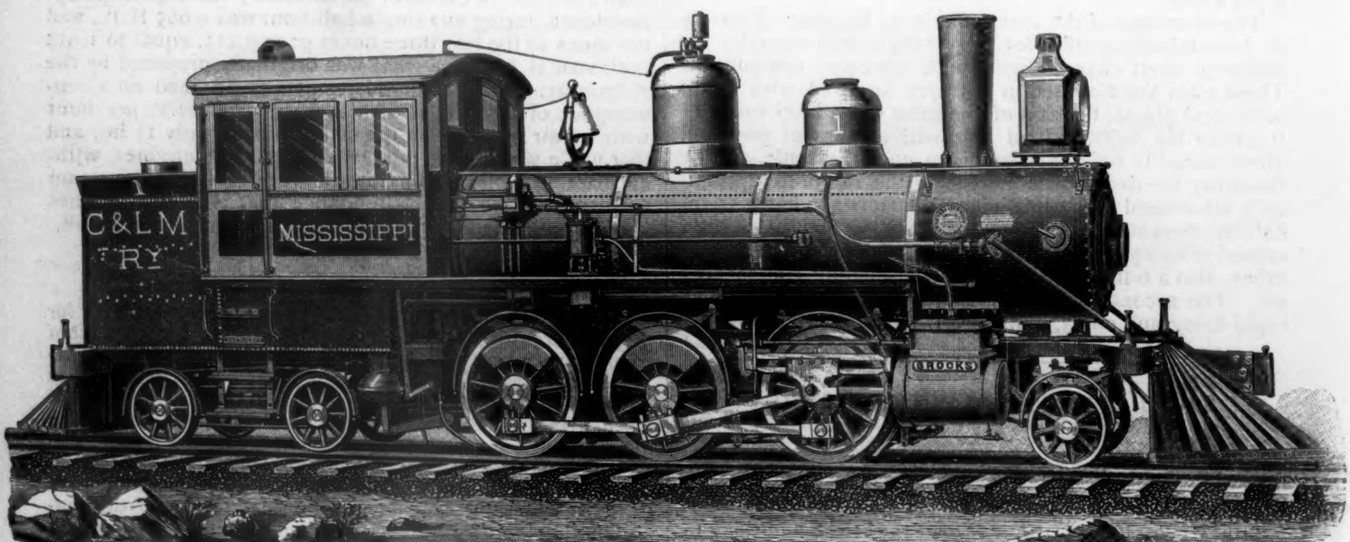
LOCOMOTIVE FOR LOCAL PASSENGER SERVICE.

BY THE TAUNTON LOCOMOTIVE MANUFACTURING COMPANY, TAUNTON, MASS.

Total weight in working order	118,700 lbs.
Total weight on driving-wheels	56,300 "
Diameter of driving-wheels	5 ft. 3 in.
Diameter of truck-wheels	2 " 2 "
Diameter of main driving-axle journal.	7½ "
Distance from center of front to center of back driving-wheel	6 ft. 8 "
Total wheel-base of engine	16 " 4 "
Total wheel-base of engine and tender	34 " 5 "
Diameter of cylinders	17 "
Stroke of cylinders	20 "
Outside diameter of smallest boiler ring.	54 "

Length of fire-box, inside	5 ft. 0 in.
Width of fire-box, inside	2 " 10½ "
Depth of fire-box, crown-sheet to top of grate	5 " 4 "
Number of tubes	170
Outside diameter of tubes	2 in.
Length of tubes	10 ft. 10¾ "
Grate surface	14 sq. ft.
Heating surface, fire-box	96¼ " "
Heating surface, tubes	1,097 " "
Heating surface, total	1,193¼ " "

Exhaust nozzles	Single.
Size of steam-ports	17×1 in.
Size of exhaust-ports	17×2½ "
Throw of eccentrics	4½ "
Greatest travel of valve	5 "
Outside lap of valve	0¾ "
Smallest inside diameter of chimney	1 ft. 4 "
Height, top of rail to top of chimney	13 " 6 "
Height, top of rail to center of boiler	6 " 8 "
Water capacity of tank	2,200 gals.



SIX-COUPLED RAPID TRANSIT LOCOMOTIVE.

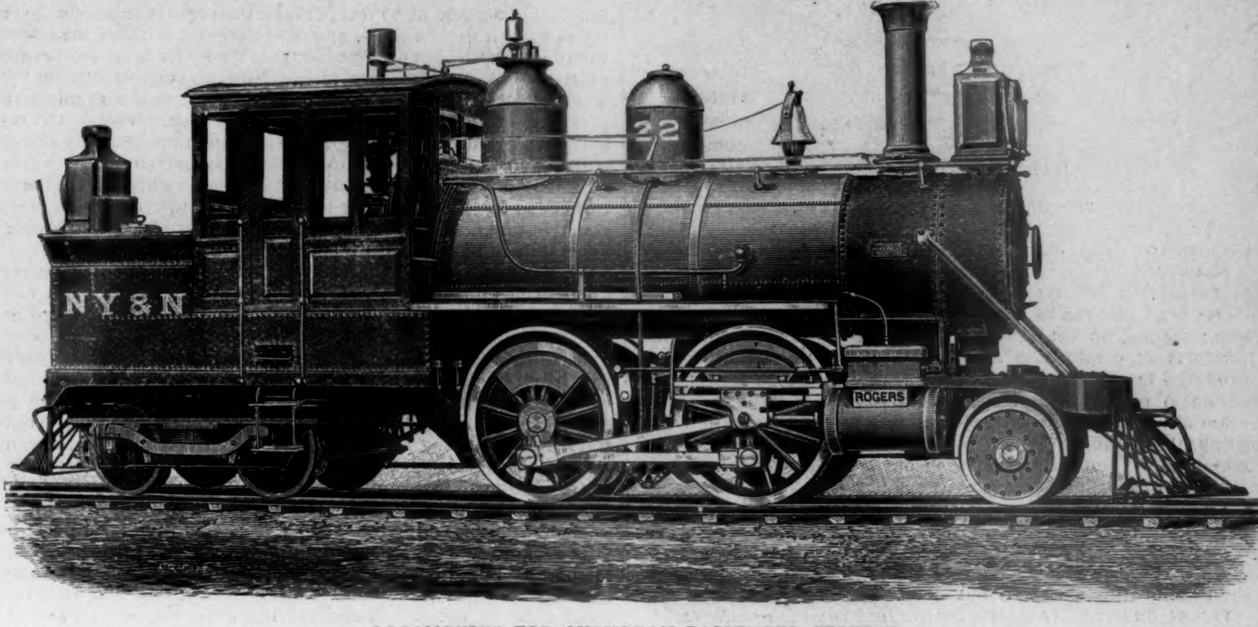
BY THE BROOKS LOCOMOTIVE WORKS, DUNKIRK, N. Y.

Total weight in working order	112,000 lbs.
Total weight on driving-wheels	70,000 "
Diameter of driving-wheels	4 ft. 0 in.
Diameter of truck-wheels	2 " 4 "
Diameter of main driving-axle journal.	7 "
Distance from center of front to center of back driving-wheel	10 ft. 0 "
Total wheel-base of engine	30 " 0 "
Diameter of cylinders	16 "
Stroke of cylinders	24 "
Outside diameter of smallest boiler ring	54 "

Length of fire-box, inside	6 ft. 6 in.
Width of fire-box, inside	2 " 10 "
Depth of fire-box, crown-sheet to hand ring	5 " 1⅛ "
Number of tubes	186
Outside diameter of tubes	2 in.
Length of tubes	9 ft. 0 "
Grate surface	18¾ sq. ft.
Heating surface, fire-box	97 " "
Heating surface, tubes	870 " "
Heating surface, total	967 " "

Exhaust nozzles	Single or Double.
Size of steam-ports	15×1¼ in.
Size of exhaust-ports	15×2½ "
Throw of eccentrics	5 "
Greatest travel of valve	5¼ "
Outside lap of valve	0¾ "
Smallest inside diameter of chimney	1 ft. 1 "
Height, top of rail to top of chimney	13 " 2 "
Height, top of rail to center of boiler	6 " 4½ "
Water capacity of tank	2,000 gals.

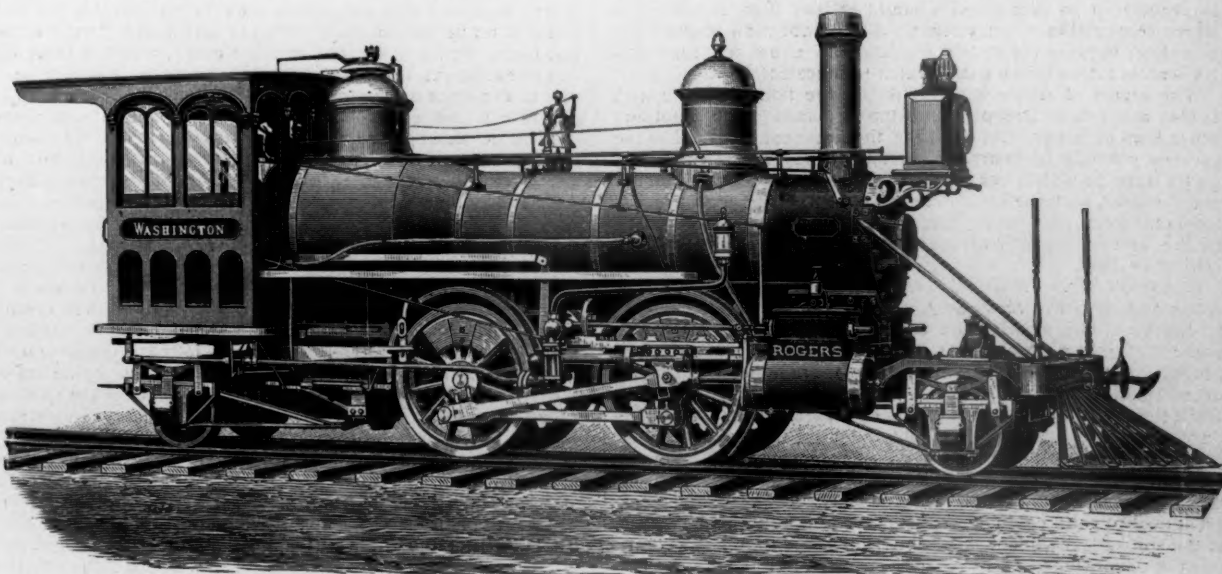
CATECHISM OF THE LOCOMOTIVE.



LOCOMOTIVE FOR SUBURBAN PASSENGER SERVICE.

BY THE ROGERS LOCOMOTIVE & MACHINE WORKS, PATERSON. N. J.

Total weight in working order	98,500 lbs.	Length of fire-box, inside	5 ft. 11½ in.	Exhaust nozzles	Double.
Total weight on driving-wheels	50,000 "	Width of fire-box, inside	3 " 5 "	Size of steam-ports	14×1⅛ in.
Diameter of driving-wheels	4 ft. 6 in.	Depth of fire-box, crown-sheet to top of grate	{ 3 " 0 " / 3 " 5¾ "	Size of exhaust-ports	14×2½ "
Diameter of truck-wheels	2 " 9 "	Number of tubes	186	Throw of eccentric	5 "
Diameter of main driving axle-journal	6⅛ "	Outside diameter of tubes	1¾ in.	Greatest travel of valve	5 "
Distance from center of front to center of back driving-wheels	6 ft. 3 "	Length of tubes	7 ft. 10¾ "	Outside lap of valve	0¾ "
Total wheel-base of engine	27 " 0 "	Grate surface	20½ sq. ft.	Smallest inside diameter of chimney	11⅛ "
Diameter of cylinders	14 "	Heating surface, fire-box	77¾ " "	Height, top of rail to top of chimney	14 ft. 0 "
Stroke of cylinders	22 "	Heating surface, tubes	667¾ " "	Height, top of rail to center of boiler	6 " 10⅛ "
Outside diameter of smallest boiler ring	52 "	Heating surface, total	745½ " "	Water capacity of tank	1,000 gals.



HUDSON DOUBLE-ENDER LOCOMOTIVE.

BY THE ROGERS LOCOMOTIVE & MACHINE WORKS, PATERSON, N. J.

Total weight in working order	51,100 lbs.	Length of fire-box, inside	4 ft. 3 in.	Exhaust nozzles	Double.
Total weight on driving-wheels	30,500 "	Width of fire-box, inside	2 " 1 "	Size of steam-ports	10⅛×1⅛ in.
Diameter of driving-wheels	4 ft. 0¾ in.	Depth of fire-box, crown-sheet to top of grate	4 " 0¾ "	Size of exhaust-ports	10½×2½ "
Diameter of truck-wheels	2 " 2 "	Number of tubes	100	Throw of eccentric	4⅛ "
Diameter of main driving-axle journal	5½ "	Outside diameter of tubes	2 in.	Greatest travel of valve	4¾ "
Distance from center of front to center of back driving-wheels	6 ft. 0 "	Length of tubes	10 ft. 2½ "	Outside lap of valve	0⅛ "
Total wheel-base of engine	22 " 1 "	Grate surface	8⅝ sq. ft.	Smallest inside diameter of chimney	10⅜ "
Total wheel-base of engine and tender	39 " 2½ "	Heating surface, fire-box	61 " "	Height, top of rail to top of chimney	11 ft. 4½ "
Diameter of cylinders	12 "	Heating surface, tubes	534⅜ " "	Height, top of rail to center of boiler	5 " 7 "
Stroke of cylinders	20 "	Heating surface, total	595⅜ " "	Water capacity of tank	1,250 gals.
Outside diameter of smallest boiler ring	39⅜ "				

CATECHISM OF THE LOCOMOTIVE.

(Revised and enlarged.)

By M. N. Forney.

(*Continued from page* 90.)

CHAPTER XXIV. (*Continued.*)

PROPORTIONS OF LOCOMOTIVES.

Question 623. *On what does the steam-generating capacity of a boiler depend?*

Answer. First, upon the size of its grate and fire-box, because more fuel can be burned in a large fireplace than in a small one; second, on the amount of heating surface to which the products of combustion are exposed; and, third, on the draft produced by the blast or exhaust steam. Of course the amount of steam generated is also dependent upon a great variety of other circumstances, such as the nature of the combustion, the firing, the arrangement of the fire-box, grates, etc., and the condition of the heating surfaces; but these have nothing to do with the proportions or size of the boiler.

Question 624. *What are the proportions of boilers used in locomotives like that which has been illustrated in these articles and represented in Plates III-V?*

Answer. The area of the grate is about 18 square feet, and the total heating surface about 1,600 square feet.

Question 625. *At what speed are such engines usually run?*

Answer. The speed varies so much under different circumstances, that it is impossible to give even approximately the average speed of such engines.

Question 626. *In what respects is the operation of locomotive boilers different from that of nearly all other steam boilers?*

Answer. The amount of steam generated in proportion to the amount of heating surface is much greater in locomotive boilers than in any other kind. To produce combustion which will be sufficiently active to generate the requisite quantity of steam, the fire must be stimulated by the blast created by the exhaust steam to a degree unknown in other kinds of boilers. So rapid is the movement of the products of combustion that a smaller proportion of the heat is imparted to the water contained in the boiler, and consequently a less amount of water is evaporated in proportion to any given amount of fuel than in boilers in which combustion is less violent. The combustion is often less complete, because the strong draft does not allow time for a perfect combination of the gases which produce combustion.

The supply of steam which a locomotive boiler must furnish is also much more irregular than the demands made upon any other kind of boiler. At one time the fire must be urged to the greatest possible intensity, in order to furnish steam enough to pull a train up a steep grade. When the top is reached the demand ceases, and the boiler can be cooled. The load which a locomotive can pull over a given line of road is usually limited by the utmost capacity of the boiler to supply steam at these critical periods.

Question 627. *What relation is there between this irregular action and the size of the boiler?*

Answer. The smaller the boiler, or rather the larger the amount of steam which must be generated in a given time in proportion to the heating surface, the more must the fire be urged; and therefore the smaller the boiler in proportion to the work it must do, the less will be its economy. In order to produce a rapid combustion in a small boiler, it is necessary to contract the exhaust nozzles in order to create a draft strong enough. In doing this the back pressure on the pistons is very much increased, and when the blast becomes very violent a great deal of solid coal is carried through the tubes and escapes at the smoke-stack unconsumed. At the same time large quantities of unconsumed gases escape, because there is not time for combustion to take place in the fire-box. The fact that with a violent draft the flame and smoke are in contact with the heating surface for a sensibly shorter period of time also has its influence; as less heat will be imparted to the water if the products of combustion are only $\frac{1}{100}$ of a second instead of $\frac{1}{50}$ in passing through the tubes.

There is another consideration which should be taken into account in this connection, which is, that if a boiler is so small that it is worked nearly up to its maximum capacity at all times, it will be impossible to accumulate any reserve power in it in the form of water heated to a high temperature to be used as occasion may require. With a boiler having a great amount of heating surface and capacity for carrying a large quantity of water, the latter can be heated at times when the engine is not working hard, and the heat thus stored up in the water can then be used when it is most needed. Thus we will suppose that to pull a train of cars on a level 250 lbs. of steam are consumed per mile. On a grade of 30 feet per mile the resistance will be three times what it is on a level, and therefore three times the quantity of steam will be consumed, so that the boiler must then evaporate 750 lbs. of water per mile. Now, to convert 250 lbs. of water heated up to a temperature due to 130 lbs. of effective pressure, or 355.6 degrees, into steam of that pressure will require 216,575 units of heat. If at the same time that this steam is being consumed, we pump into the boiler 250 lbs. of water of a temperature of 60 degrees, 73,900 more units of heat will be needed to raise the water to the temperature due to 130 lbs. effective pressure, so that on the level part of the road it would be necessary to transmit to the water in the boiler $216{,}575 + 73{,}900 = 290{,}475$ units of heat in a mile. If there is no room in the boiler for storing a surplus quantity of hot water, it will be necessary on a grade as fast as the steam is consumed to feed an equivalent amount of cold water to take the place of that which was converted into steam, so that on a 30-feet grade it would be necessary to convert at the rate of 750 lbs. of hot water into steam in a mile, which would require 649,725 units of heats, and at the same time heat an equal amount of cold water to a temperature due to the pressure of the steam, which would require 221,700 more units. So that it will be necessary to transmit at the rate of 871,425 units of heat to the water per mile. Now, if the boiler was so large that more water could be pumped into it and heated than was used on the level portion of the road, and could be stored up in the boiler for future use, the pumps might be either partly or entirely shut off when the engine was working the hardest on the grade. In this way, instead of being obliged to convert hot water into steam, and at the same time heat an equal amount of cold feed-water, there would be a surplus of hot water stored up already heated. It would therefore only be necessary to convert this hot water into steam, which will require a transmission of heat to the water at the rate of 649,725 units of heat instead of 871,425. It must be remembered that on nearly all roads there are certain difficult places which practically limit the capacity of the locomotives on that line. If therefore the capacity of the engines can be increased at those points, their capacity over the whole line is increased. It will be seen by the above illustration that by having a large boiler it is necessary for it to do very much less work at the critical period, when, as every locomotive runner knows, it is often of the utmost importance to make use of every possible available means in order to pull the trains. It is true that on a very long grade the supply of surplus hot water would soon be exhausted, but even in such cases there is usually one place, owing to a curve or other cause, which is more difficult to surmount than any other, in which case it will be necessary to use more steam for a short time than the locomotive can generate if the boiler is fed continuously. For such cases a surplus of water can be used. But even if the resistance is equal over the whole length of the incline, still the large boiler will have the advantage, because it can at all times generate more steam than a smaller one. It may therefore, we think, safely be assumed that locomotive boilers should always be made as large as the weight of the locomotive will permit.

Question 628. *What effect does the size of the driving-wheels have upon the combustion and evaporation of locomotive boilers?*

Answer. As small wheels make more revolutions in running a given distance than large ones, there will be more strokes of the piston with the former than with the latter, if the locomotive in both cases runs at the same speed. As smaller cylinders are usually employed with small wheels, the blast up the chimney is then composed of a larger number of discharges of steam, but each one of less quantity, than when larger wheels and cylinders are used. In the one case the "puffs" of steam are many and small, and in the latter few and large. If the cylinders are proportioned by the rule which has been given for that purpose, the amount of steam discharged in running any given distance will be the same with engines of the same weight having large and those with small wheels, the only difference being that it will be subdivided into a greater number of discharges in the one case than in the other. Now, it is found that the draft of engines is much more effective on the fire when the blast is thus subdivided, that is when small wheels and cylinders are used, than it is with large ones, and therefore more steam is generated with the former than with the latter.

Question 629. *What relation is there between the size of the wheels and that of the boiler?*

Answer. As has been explained, the size of the boiler is limited by the weight of the locomotive. The boiler and its attachments of an American type of locomotive, when the former is filled with water, weigh about half as much as the locomotive; therefore unless we increase the weight of the latter or decrease

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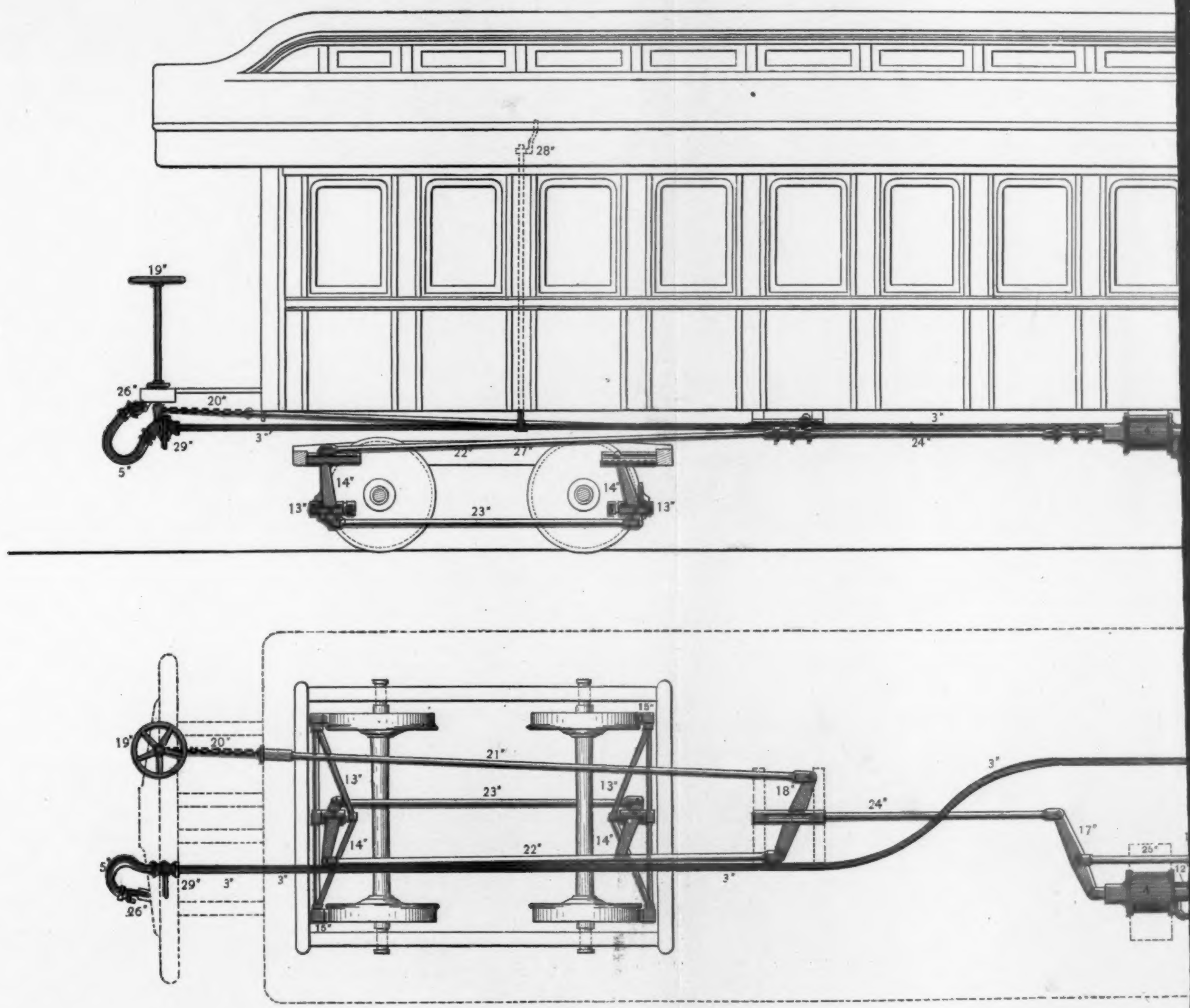

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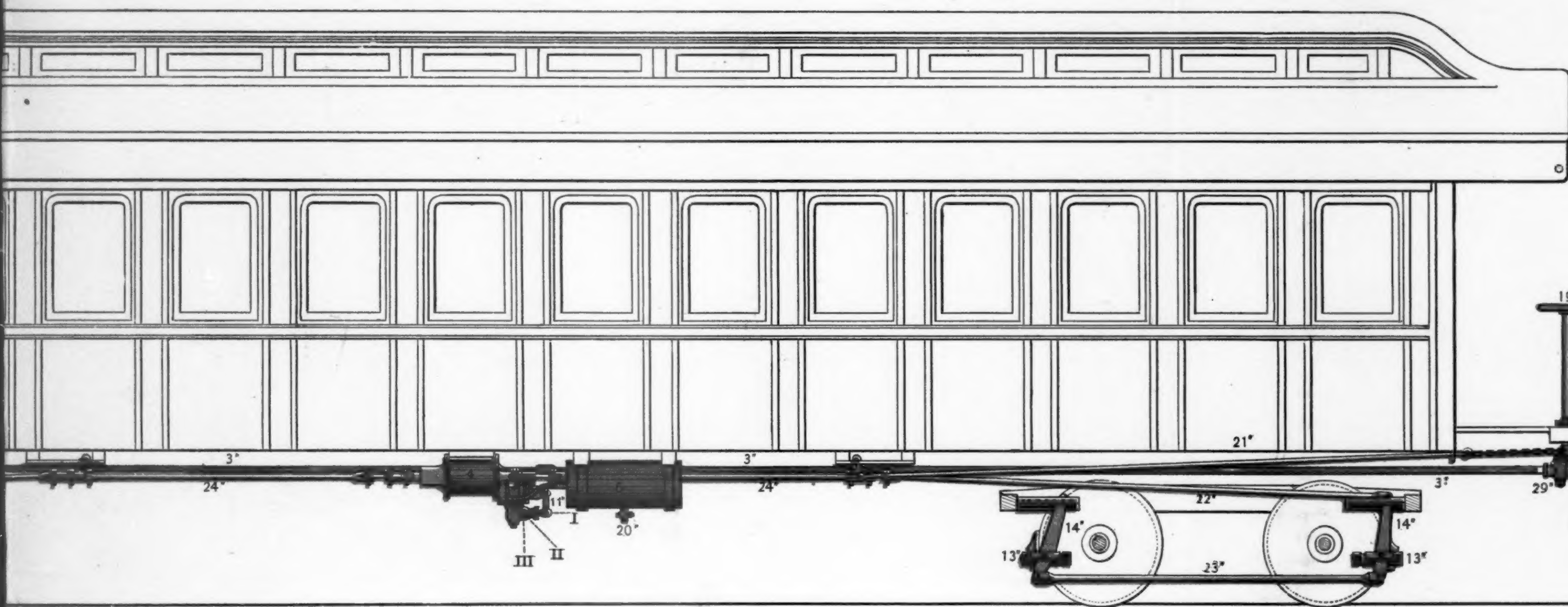

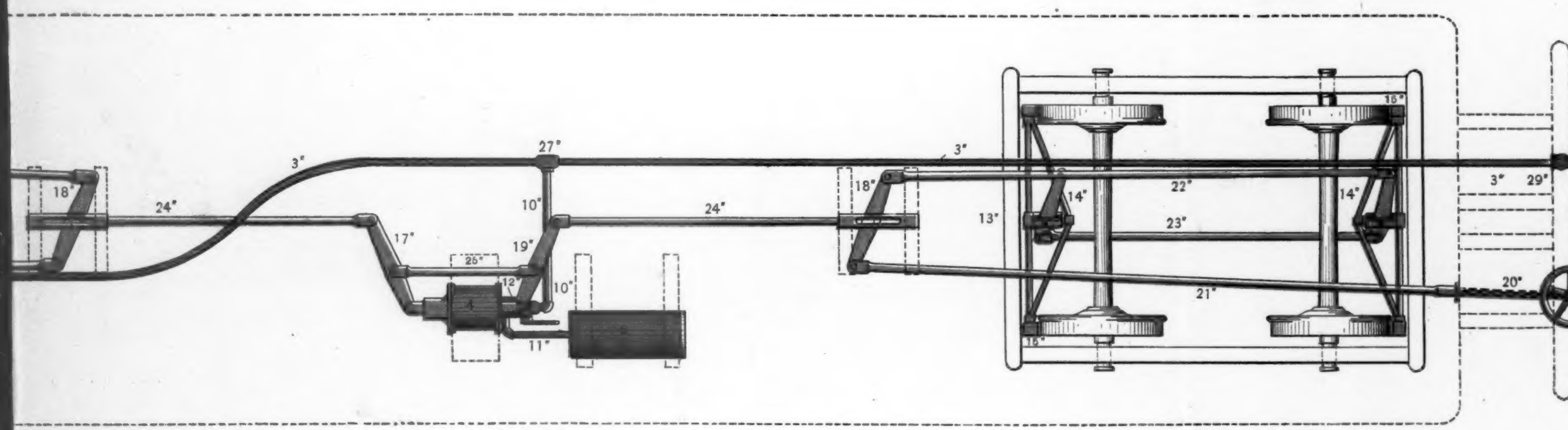

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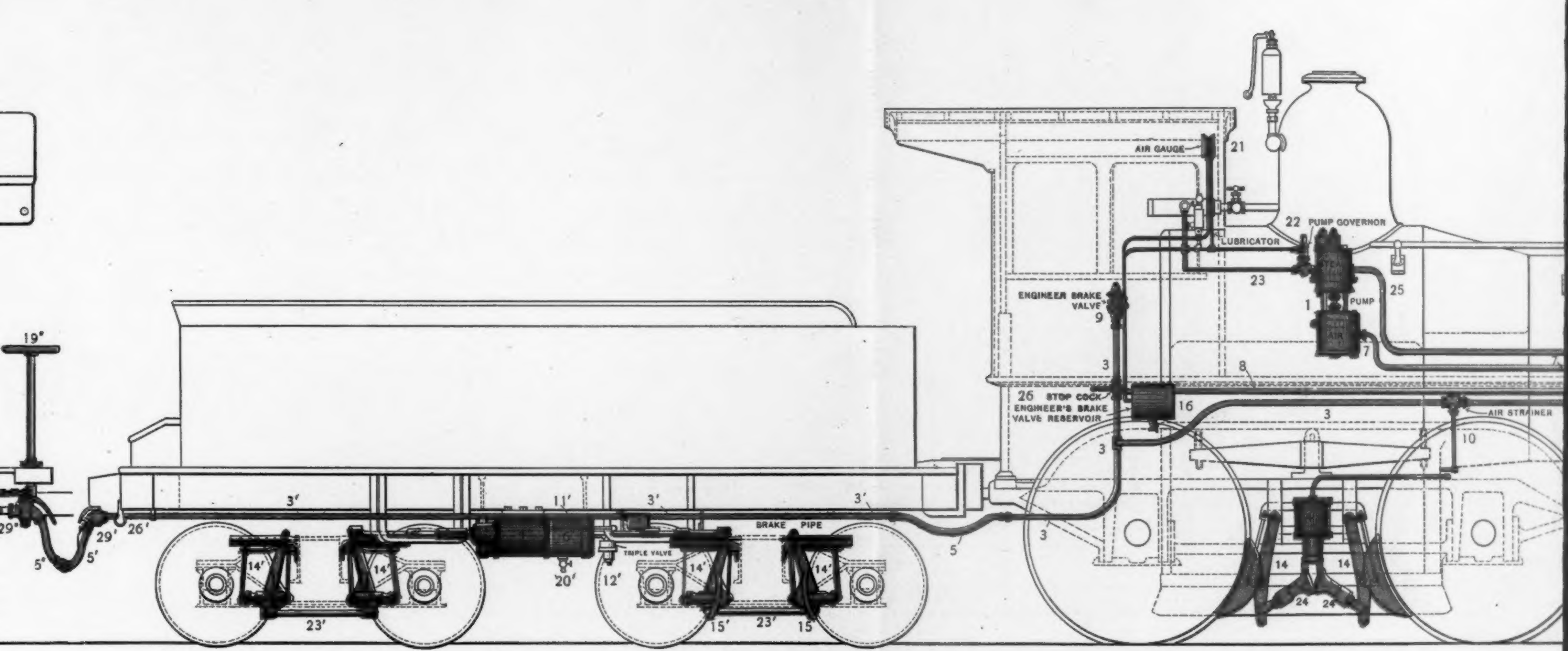

Fig. A.

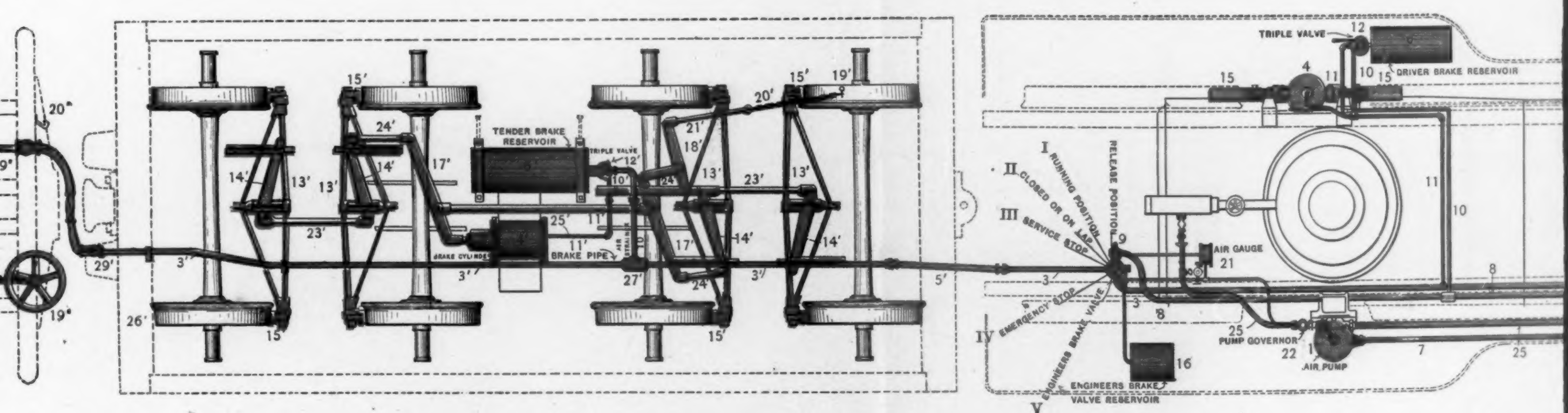

Fig. C.

GHOUSE AUTOMATIC AIR BRAKE.

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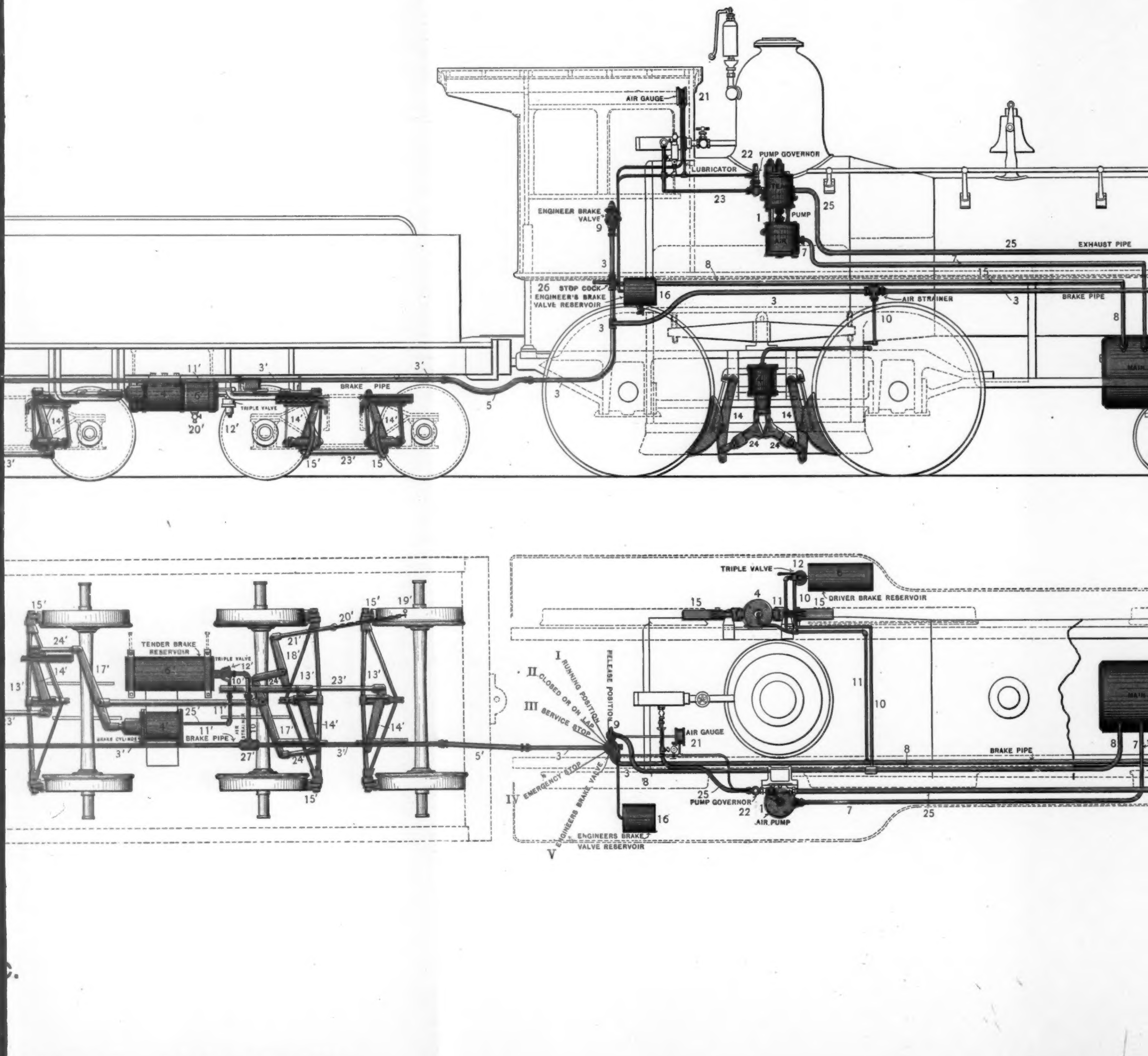
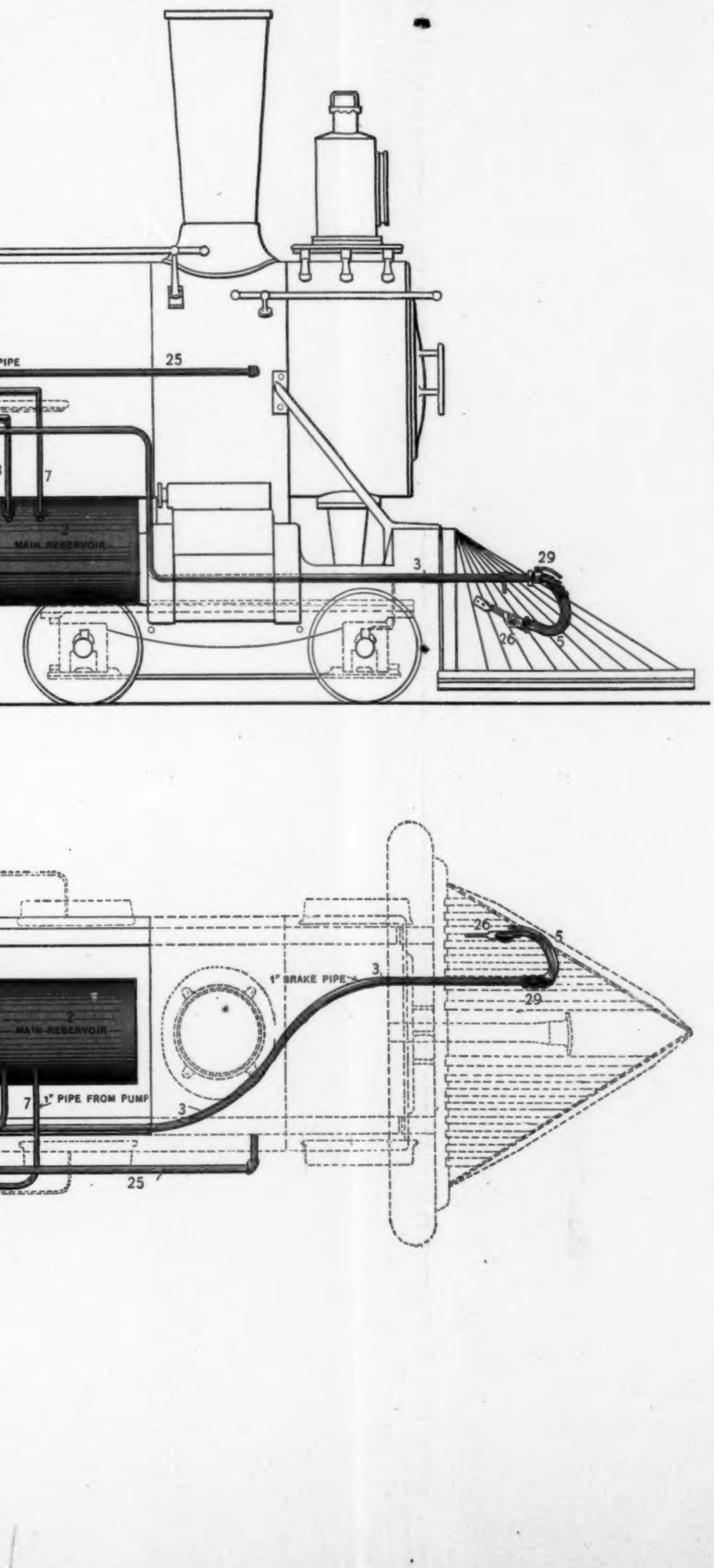


C.

OMATIC AIR BRAKE.

PLATE VI.



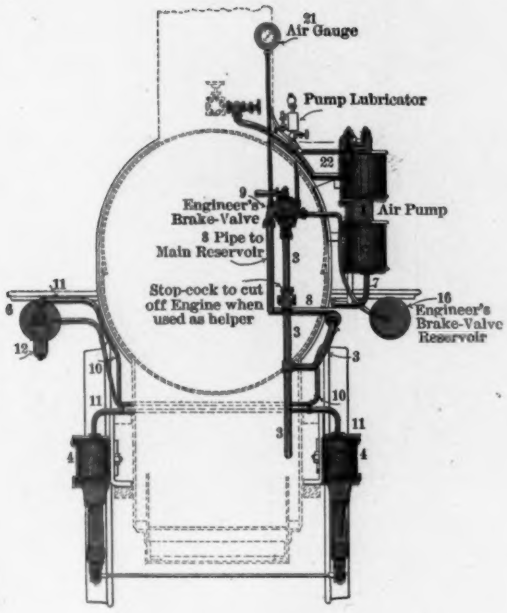


Fig. B.

the weight of the machinery, we cannot increase the size of the boiler. Now, large wheels are heavier than small ones; they require larger cylinders, stronger connections, heavier frames, and in fact nearly all the parts of the machinery used with large wheels must be heavier than are required when small wheels are used. Therefore, by decreasing the size of the wheels all the other parts of the engine proper can be made lighter than is possible if large wheels are used, and thus the size and weight of the boiler can be increased without increasing the whole weight of the locomotive. There is, of course, a practical limit below which the size of the wheels cannot be reduced, because the speed of the piston would become so great as to be injurious to the machinery. By reducing the stroke, however, with the diameter of the wheels, the evil referred to may be obviated to a great extent. A cylinder with a large diameter and comparatively small stroke has also the advantage that there is less surface exposed to radiation of heat than there is in a cylinder in which these proportions are reversed.

CHAPTER XXV.

THE WESTINGHOUSE AUTOMATIC AIR-BRAKE.

QUESTION 630. *What are the brakes on locomotives, tenders, and cars for?*

Answer. The brakes are for the purpose of reducing the speed of such vehicles, or stopping them quickly when they are moving.

QUESTION 631. *How are brakes usually constructed and operated?*

Answer. The brakes which are most commonly used on railroads consist of metal or sometimes wooden shoes, which are attached to transverse beams, and suspended so that the shoes can bear or rub against the treads of the wheels. The beams are connected to levers, and the levers are connected together by rods and by a chain to a windlass, which is wound up by a crank or hand wheel, and the brake-shoes are thus pressed against the treads of the wheels, and the friction which is thus produced resists the motion of the vehicle and causes it to run slower or stops it.

QUESTION 632. *What difficulty is encountered in using brakes of this kind which are applied by hand?*

Answer. In cases of danger it takes too much time to apply such brakes. If a fast-running train encounters any obstacle or obstruction on the track the brakes cannot be applied quickly enough to stop the train in time to avoid an accident.

QUESTION 633. *What was the air-brake designed for?*

Answer. It was designed to apply brakes quickly by means of compressed air instead of hand power, and also to place the control of the brakes in the hands of the locomotive runner.

QUESTION 634. *How were the first air-brakes constructed?*

Answer. The first air-brakes designed by Mr. Westinghouse consisted of an air-pump, driven by steam, on the locomotive for compressing the air, and a reservoir on the engine or tender for holding the compressed air. The tender and each car had a cylinder and piston underneath its body, the pistons of which were connected to the brake-levers. Each car had a pipe, called a brake-pipe, extending its whole length and connected to the brake cylinder, the pipes on adjoining cars and the tender being connected together by flexible hose. The tender-pipe was connected to the air reservoir with a valve, by which communication could be opened or closed between the pipe and the reservoir. The latter was pumped full of air of a pressure of 30 or 45 lbs. per square inch. When it was desired to apply the brakes, communication was opened between the air reservoir and the train-pipe. The compressed air in the reservoir then flowed through the train-pipes to the cylinders and forced the pistons outward. The force exerted on the pistons was communicated to the brake-levers, thus pressing the brake-shoes against the wheels. This form of brake was named the "*straight*" air-brake by the men who used it.

QUESTION 635. *What difficulty was encountered in using this form of brake?*

Answer. If the train consisted of more than a few cars considerable time was required for the air to flow from the reservoir through the brake-pipes to the cylinders. When danger is imminent a very small fraction of time is of the utmost importance. It was therefore found that this form of air-brake would not act quickly enough in case of danger, and it was also found that in the event of the bursting of a coupling hose or brake-pipe, the supply of air to the cars behind the rupture was cut off and the air in the reservoir escaped, and the brakes would not work. As such ruptures were liable to occur at times when the brakes were most needed, it was a serious defect. It was also found that if a train broke in two that then the brakes could be applied to the front end of it and would stop it, whereas it had no control over the back portion, which was liable to run into the front part and thus cause a dangerous collision.

QUESTION 636. *How were these difficulties overcome?*

Answer. Mr. George Westinghouse, Jr., devised and in 1872 patented what is called the Automatic Air-Brake, and which is now generally used on passenger and to some extent on freight trains in this country.

QUESTION 637. *How is the automatic air-brake constructed?*

Answer. Its general arrangement is shown in Plate VI, which represents a side view and plan of a locomotive, tender, and car, and a view looking at the back end of the locomotive. The pipes and reservoirs are colored blue, and the other parts of the brake are colored red. In fig. A the running gear of the tender and car are shown in section, and in fig. B the bodies of the tender and car are supposed to be removed and are indicated by dotted lines only.

The automatic brake consists of the same parts as the first or "straight" air-brake had—that is, an air-pump, 1, figs. A, B, and C; a main reservoir, 2, a brake-pipe, 3 3, 3′ 3′, 3″ 3″, for conveying air from the main reservoir to the tender and each car behind it; cylinders and pistons, 4, 4′, 4″, on each vehicle of the train, which are connected to the brake-levers and brake-beams as shown, and as will be more fully explained further on. The brake-pipe has a flexible hose connection, 5, 5′, 5″, between adjoining vehicles which have suitable couplings for connecting and disconnecting the hose. Instead of having but one air reservoir on the engine or tender for holding compressed air, the automatic brake has separate or auxiliary reservoirs, 6, 6′, 6″, on the locomotive, the tender, and each car. The air-pump is connected to the main reservoir by a pipe 7, 7. The main reservoir is connected by another pipe, 8, 8, 8, to the engineer's brake-valve, 9. The brake-pipe 3, 3′, 3″ is connected to the engineer's valve and extends back under the tender and cars, and, as already explained, is connected together between the different vehicles by hose, 5, 5′, 5″, and to the auxiliary reservoir by pipes 10, 10′, 10″, and the auxiliary reservoirs are connected to the brake cylinders by other pipes, 11, 11′, 11″. The pipes 10, 10′, 10″ and 11, 11′, 11″ communicate with the auxiliary reservoirs through ingenious valves, 12, 12′, 12″, called triple-valves, whose construction and operation will be explained further on.

The cylinders have pistons which are connected to a system of brake-levers shown in the engravings. These levers are connected to the brake-beams 13, 13′, 13″, which have shoes on their ends that bear against the treads of the wheels.

QUESTION 638. *How does the automatic air-brake operate?*

Answer. Its operation is as follows: Before the train starts steam is let on to the air-pump, which then pumps or compresses air which passes into the main reservoir 2 through the pipe 7, 7. Communication is then opened by means of the engineer's valve between the pipe 8, 8, which is connected to the main reservoir and the brake-pipe 3, 3′, 3″.

The compressed air then flows from the main reservoir through the pipe 8, 8, engineer's valve 9, and brake-pipe 3, 3′, 3″, thence through the branch pipes 10, 10′, 10″ and triple-valves 12, 12′, 12″ to the auxiliary reservoirs. When the reservoirs and brake-pipe are filled with compressed air of about 70 lbs. pressure per square inch, the train is ready to start.

The triple-valves are constructed so that as long as the brake-pipe is filled with compressed air communication between the auxiliary reservoirs 6, 6′, 6″ and the brake-cylinders 4, 4′, 4″ is closed, but as soon as the pressure in the brake-pipe is reduced the triple-valves open communication between the auxiliary reservoirs 6, 6′, 6″ and the brake-cylinders 4, 4′, 4″ through the pipes 11, 11′, 11″. If, then, some of the compressed air in the brake-pipe is allowed to escape, and the pressure in it is thus reduced, the triple-valves will open, so that the air in the auxiliary reservoirs can flow into the brake cylinders, which will then force out the pistons and apply the brakes. The engineer's valve is constructed so that by turning a handle shown at 9 in the plan it allows the air in the brake-pipe to escape, which reduces the pressure in the pipe. To apply the brakes, then, all that the engineer must do is to turn the handle of the valve 9.

QUESTION 639. *After the brakes have been applied, how are they released?*

Answer. The handle of the engineer's valve 9 is turned so as to close the opening for the escape of the air from the brake-pipe, and at the same time communication is made between the main reservoir and the brake-pipe. The compressed air stored in the main reservoir then flows into the brake-pipe, which closes the triple-valves, and at the same time they allow the air in the cylinders to escape, and a spring in the pistons forces them inward and releases the brakes.

QUESTION 640. *In practice what is essential in applying automatic brakes?*

Answer. In case of danger it is essential that the brakes should be applied as quickly as possible, and it is also important that the engineer should be able to apply them either gradually

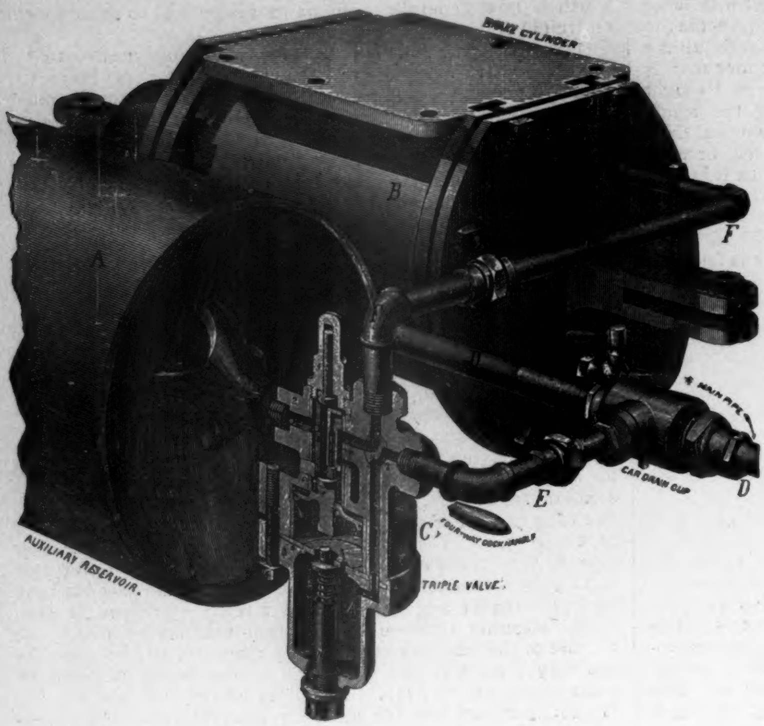


Fig. 368.

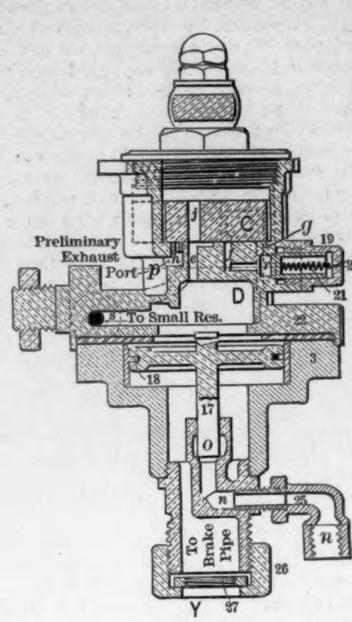


Fig. 373.

Fig. 374.

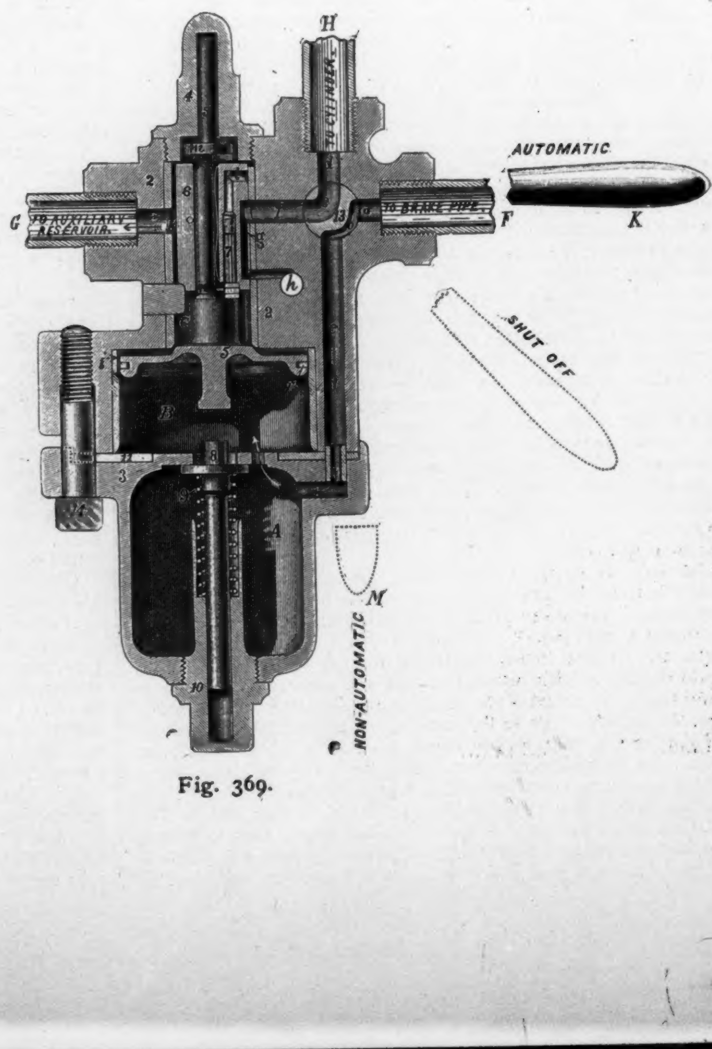


Fig. 369.

or as rapidly as circumstances may require—in other words, that he should be able to regulate the pressure on the brake-shoes to stop slowly or quickly, or to increase or diminish it at pleasure, or at times release the pressure on the wheels instantly.

QUESTION 641. *What is meant by the automatic action of the brakes?*

Answer. It has been explained that when the pressure of the air in the brake-pipe is reduced, that the triple-valves open communication between the auxiliary reservoirs and the brake cylinders so that the compressed air in the reservoirs then flows into the cylinders and applies the brakes. If therefore a coupling hose should burst or a train break in two, or any other accident should occur so that the compressed air in the brake-pipe would escape, the brakes would go on of themselves, or be applied *automatically*.

QUESTION 642. *On what does the automatic action of the brakes depend?*

Answer. Chiefly in the triple-valves and their connection with the auxiliary reservoirs and the brake-cylinders. Fig. 368 is a perspective view, and shows one end of the auxiliary reservoir *A*, the cylinder *B*, with the triple-valve *C* shown in section. *D D* is the brake-pipe, to which the triple-valve is connected by the pipe *E*. It is also connected to the cylinder *B* by the pipe *F F*, and to the auxiliary reservoir by the connection 2.

QUESTION 643. *How is the triple valve constructed, and what is its operation?*

Answer. Its construction is shown in fig. 369, which represents a section of the valve. It consists of a piston, 5, which works in the cylindrical chamber *B*. The rod or stem of this piston engages with a slide-valve, 6. When the engineer's valve is turned so that there is communication from the main reservoir through the valve to the brake-pipe, the air from the reservoir enters the triple-valve at *F*, passes through the four-way cock 13 by passages *a b c* and drain-cup *A* to the cylinder *B*, forcing the piston 5 into its normal position as shown in the engraving. The air then flows through a small groove—shown at *i* on the left-hand side of the piston—past the piston into the valve chamber *C* above it, and through the passage *C k* and pipe *G* into the auxiliary reservoir, while at the same time there is an open communication from the brake-cylinder to the atmosphere through the pipe *H* and passages *d e f g h*. Air will thus continue to flow into the auxiliary reservoir until it is filled with air of the same pressure as that in the brake-pipe.

If now the air in the main brake-pipe *F* is allowed to escape by means of the engineer's valve, or through accident, such as the bursting of a hose, the pressure of the air in the brake-pipe *F* and chamber *B*, below the piston 5, will be reduced, whereupon the greater pressure in the auxiliary reservoir and above the piston 5 will force it downward past the groove at *i* and close it. As the piston descends it moves the slide-valve 6 with it and uncovers the passage *f* so as to permit air to flow directly from the auxiliary reservoir through the pipe *G*, passages *k f e d* and pipe *H* into the brake-cylinder, which applies the brake.

To release the brakes, air from the main reservoir must be admitted, by means of the engineer's valve, into the main brake-pipe from the main reservoir. As the pressure in the main reservoir is greater than that in the auxiliary reservoir, it forces the piston 5 and slide-valve 6 back to the position shown in the engraving, which allows the air in the brake-cylinder to escape through the pipe *H* and passage *d e f g h*.

To apply the brakes gently, a slight reduction is made in the pressure in the main brake-pipe, which moves the piston down slowly. The slide-valve 6 has a conical valve, 7, called a *graduating valve*, which closes the passage *l*. A pin, *n*, in the piston-rod engages with the valve 7, so that when the piston first begins to move downward it pulls the valve 7 with it and opens the passage *l*. As the piston moves further the collar *m* engages with the slide-valve and carries it downward with it until the port *l* is over the passage *f* and the piston 5 comes in contact with the graduating stem 8 and spring 9. Air from the auxiliary reservoir then flows through holes (shown by dotted lines above 7) in the side-valve, and passes by the passages *l f e d* to the brake-cylinder. When the pressure in the auxiliary reservoir has been reduced, by expanding into the brake-cylinder, until it is of the same pressure as that in the main brake-pipe, the graduating spring 9 pushes the piston up far enough to close the small valve 7. This causes whatever pressure there is in the brake-cylinder to be retained there, thus applying the brakes with a force proportionate to the reduction of pressure in the brake-pipe. It will thus be seen that it is important to be able to regulate and control the pressure in the main brake-pipe. This is done by means of the engineer's brake and equalizing discharge-valve.

QUESTION 644. *What is the four-way cock* 13, *fig.* 369, *for?*

Answer. This cock is used to shut off the brake cylinder and auxiliary reservoir with which it is connected, if from any cause it is desirable to have the brake on any particular car inoperative. To do this the handle *K*, which is connected to the plug 13, of the cock is turned from a horizontal position, *K*, to an intermediate one, shown by the dotted lines. This leaves the main brake-pipe unobstructed to supply air to the other vehicles in the train. If the handle *K* of the cock is turned down to the position indicated by the dotted lines at *M*, there is then a direct communication from the main brake-pipe to the brake-cylinder through a channel *a e d*—the triple-valve and auxiliary reservoir being cut out—and the apparatus can be worked as a non-automatic brake by admitting air into the main brake-pipe and brake-cylinder to apply the brakes.

QUESTION 645. *What is the lower chamber A for?*

Answer. This is called a *drain-cup*, and its object is to collect any water which may accumulate in the pipes. The water can be removed by unscrewing the plug 10 in the bottom of the cup.

QUESTION 646. *Why is it essential to have an excess of pressure in the main reservoir over that in the main pipe and auxiliary reservoirs?*

Answer. When the brakes are applied, as has been explained, the piston 5 in the triple-valve, fig. 369, is forced down in the cylinder *B*. To release the brakes this piston must be forced up in the cylinder to the position shown in the engraving. To do this promptly and with certainty it is absolutely essential in long trains, and is of great importance in short ones, to have an *excess* of pressure in the main reservoir, so that when air is admitted to the brake-pipe the pressure below the pistons in the triple-valves will be considerably greater than that above it. If it is not considerably greater it may not raise the pistons into the position they must occupy to release the brakes. The method of increasing the pressure in the main reservoir will be explained further on.

QUESTION 647. *How is the engineer's brake and equalizing discharge valve constructed, and how does it operate?*

Answer. The construction of this valve is shown in figs. 370 to 378, fig. 370 being a vertical section on the line *I t* of fig. 371, which is a plan with the valve 13 removed, and fig. 373 a similar section on the irregular line *v h e f r* 19 of fig 374; fig. 374 a horizontal section on the line *p q* of 370. The pipe *X* connects with the main reservoir, and *Y* with the brake-pipe. Fig. 372 is a plan of the rotary valve 13. This valve has an opening or "supply port," *a* (shown also in fig. 370), and a cavity, *c*, in its under side analogous to the exhaust cavity in an ordinary slide-valve. This cavity is represented by dotted shade lines in the plan, and also in figs. 375 to 378. The valve also has another small port, *j*, which passes entirely through it—as shown in fig. 373—and a small cavity, *p*, also indicated by dotted shade lines in the various plans.

Fig. 375 represents a plan of the rotary valve 13 on its seat, in the position it would be placed to release the brakes, and where it would be left when the engine has completed its run. To prepare for another run, steam is turned on and the air-pump is started, which forces air into the main reservoir, which is connected to the engineer's valve by the pipe *X*, fig. 370. When the rotary valve is in the position shown in fig. 375 the *supply-port a* in the valve is over the cavity *b* in the valve-seat. This cavity is also shown in figs. 370 and 371, and in figs. 375 to 379 the part which is uncovered by the port *a* is represented by black shading, and that which is covered by the valve is shaded with round dots. When the valve is in the position shown in fig. 375 the cavity *c* in its under side is over the supply cavity *b* and also over the port *l*, which communicates with the main-brake-pipe, as shown in fig. 370. When the valve is in the position shown air can flow from the main reservoir up through the pipe *X*, fig. 370, into the supply port *a*, in the valve, and into the cavity *b* in the valve-seat, then up into the cavity *C* in the under side of the valve, and from there down into the direct application and supply port *l l*, which communicates with the main brake-pipe *Y*, from which it passes to the triple-valves and through them to the auxiliary reservoirs. When the rotary valve is in this position, the port *j* in the valve is over the port *e* in the seat, which is connected with the chamber *D*, as shown by dotted lines in fig. 370. Air from the main reservoir can therefore flow into the chamber *D* above the piston 17, and thence through the port *s*, which communicates with the pipe *T* (as shown by dotted lines *s*, *s'*, *s'*, fig. 374), and thence to a small reservoir, 15, Plate VI, that is usually suspended under the running board of the engine. The purpose of this reservoir is to add to the volume of the chamber *D*.

When the auxiliary reservoirs are filled with compressed air the rotary-valve is then turned to the II position, or "*while running*" position, shown in fig. 371 and 377. In this position communication between the supply port *a* in the valve and the port *l* in its seat is closed. A small hole, *j*, in the valve then comes over the small feed-port *f* in the seat, which is connected

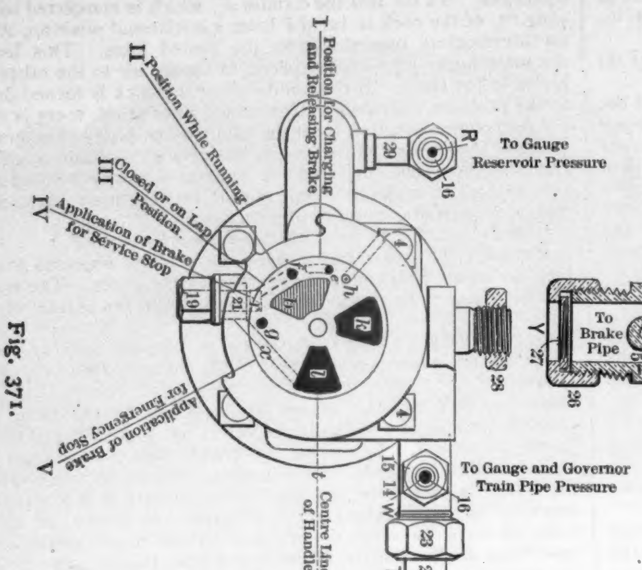


Fig. 371.

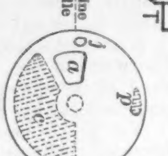


Fig. 372.

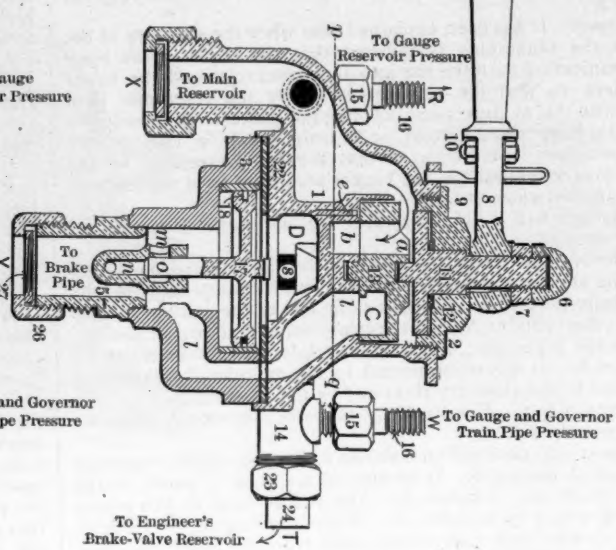


Fig. 370.

Fig. 376.

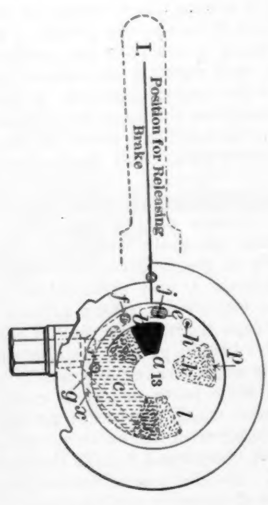
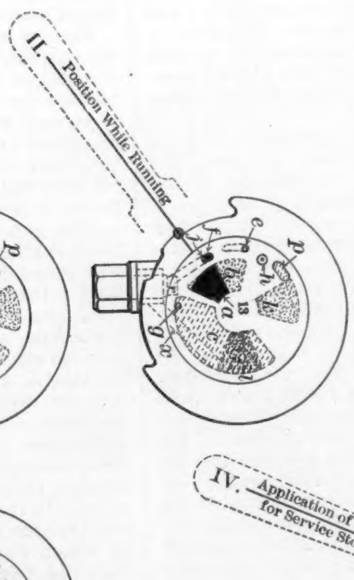


Fig. 375.



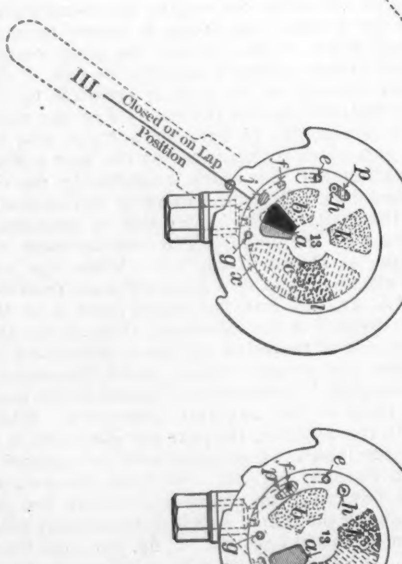


Fig. 377.

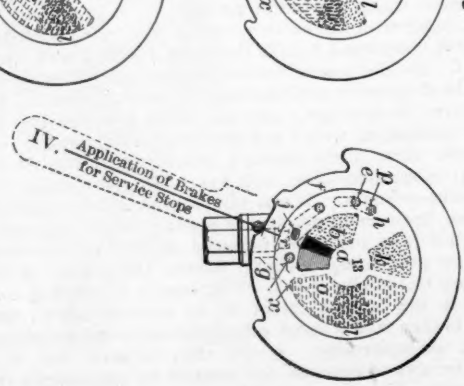


Fig. 378.

Fig. 379.

to the cavity *r* under the "*feed-valve*" 21, as shown in figs. 371 and 374, so that air can then flow from the main reservoir through the brake-pipe *X*, port *f*, and passage *f* into the cavity *r*. The feed-valve is pressed down on its seat by a spiral spring, 20, figs. 373 and 374, which has a resistance equivalent to a pressure of air of about 20 lbs. per square inch. When this additional pressure is accumulated in the main reservoir the feed-valve is forced open, and the air which escapes passes through the "feed-port" or channel *m*, fig. 374, to the port *l*, and thence to the brake-pipe *Y*, fig. 370. At the same time air can pass from the port *l*, see fig. 376, into the cavity *c* under the valve, and thence down through the equalizing port *g*, in the valve-seat, which, as shown in fig. 373, communicates with the cavity *D* above the piston 17. The same pressure is therefore maintained in the chamber *D* that exists in the feed-port, so that the pressure above and below the piston is thus equalized. The stem *o*, fig. 370, of the piston forms a small conical valve which is seated above the passage *n*, and closes it when down. The passage *n* communicates with the atmosphere—see fig. 373—so that if the piston is moved upward and opens the valve, it allows air in the brake-pipe to escape. It will thus be seen that when the rotary-valve is in position II, fig. 376, that the same pressure is maintained in the chamber *D*, fig. 370, that exists in the brake-pipe. When the valve is in this position no air can pass from the main reservoir to the brake-pipe until its pressure is sufficient to open the feed-valve 21, which requires a pressure of 20 lbs. per square inch. As the pressure in the brake-pipe is exerted against the opposite side of the valve 21, it will require an excess of pressure of 20 lbs. in the main reservoir over that in the brake-pipe before the valve 21 will be opened, and when it does open air from the main reservoir will flow through the pipe *X* (see figs. 371 and 374), port *j*, passage *f*, into the cavity *r*, and thence through the feed-port *m*, and thence into the cavity *l l* and brake-pipe *Y*. Consequently when the rotary-valve is in the position II, the pump will fill the main reservoir with air of a pressure 20 lbs. greater than that in the brake-pipe, the object of which has already been explained.

To apply the brakes for making ordinary stops at stations, or service stops, as they are called, the handle 8 of the rotary-valve is turned into position III, figs. 371 and 377. When in this position all communication through the valve and its seat is closed. The valve handle should then be moved to the IV position, or that for the "application of brakes for service stop." A small exhaust cavity, *p*, figs. 372 and 377, on the under side of the rotary-valve 13 then establishes communication between the two "*preliminary exhaust-ports*" *e* and *h*, figs. 371 and 377, in the valve-seat. The first of these, *e*, connects with the chamber *D*, as shown in fig. 373, and the second, *h*, leads to the atmosphere (see fig. 374). Air can therefore escape up from the chamber *D*, see fig. 370, through the passage *e*, cavity *p*, and down the passage *h* to the atmosphere. It will be remembered that the chamber *D* is connected by the passage *S* and pipe *T*, figs. 370 and 374, with the brake-valve reservoir 15, Plate VI. A pressure-gauge, 23, Plate VI, is connected by a pipe, 24, 24, to the branch *W*, fig. 370, which communicates with the chamber *D*.

The gauge 23 has two sets of works in it, one of them connected as described, and the other connected by a pipe, 25, 25, Plate VI, to the pipe which leads to the main reservoir. The two hands of the gauge thus indicate the pressure in the main reservoir and also in the chamber *D*.

In making an ordinary stop, after the pressure in *D* has been reduced about 8 lbs., the handle of the engineer's valve should be restored to the III, or closed position. This reduction of pressure in *D* will cause the air below the piston 17, fig. 370, to force it and its stem upward, which will open the valve at *o* and allow air in the brake-pipe *Y* to escape to the atmosphere through the ports *m* and passage *n*, thus applying the brakes gently. This discharge of air continues after the valve handle is carried to the III or "closed" position—which allows the pressure in the brake-pipe to gradually equalize itself through the whole length of the train—and the escape of air from the brake-pipe does not cease until the pressure in it has been reduced slightly lower than that yet remaining in the chamber *D* above the piston. The latter is then forced downward, which closes the outlet at *o* and prevents the further escape of air, until the operation is repeated, which may be necessary to apply the brakes with the desired force.

QUESTION 648. *What difficulty in the application of brakes is the feature of the engineer's brake and equalizing valve, which has been described last, intended to overcome?*

Answer. In applying the brakes, especially on long trains, if the engineer, instead of allowing the air to escape slowly from the brake-pipes, allows a considerable amount of air to escape in a short time and then closes the valve suddenly, the air is exhausted from the front end of the brake-pipe which applies the brakes on the front cars before the pressure in the pipe has equalized itself. The air in the back end of the pipe then rushes forward, and if the valve has been closed suddenly this rush of air acts on the triple-valves and is liable to release the brakes on the front cars. To avoid this difficulty, the opening of the passage *h*, figs. 371 and 373, in the valve-face is made extremely small, and the chamber *D* is connected with the brake-valve reservoir, 15, Plate VI, so as to increase the volume of air which must be discharged before the brakes are applied. As soon as the pressure above the piston 17 is reduced lower than that below it, in the brake-pipe, the piston moves upward slowly and opens the valve *o*, which permits the air in the brake-pipe to escape through the opening *n*, fig. 373. This discharge of air continues after the rotary-valve 13 has closed the opening for the escape of air from the chamber *D*, and does not cease so long as there is any difference in the pressure above and below the piston, and until the pressure in the brake-pipe has been equalized and reduced slightly lower than that yet remaining above the piston. So long as there is more pressure below the piston than above it the valve *o* remains open, and is closed very gradually as the pressure in the brake-pipes is reduced. This, as has been explained, permits the pressure in the brake-pipe to become equalized and secures a uniform application of the brakes through the whole length of the train.

When the pressure in the brake-pipe is reduced a little below that above the piston the latter is forced down, and closes the valve *o*, which prevents the further escape of air until the rotary-valve handle is again moved to the IV position, fig. 378, and the operation is repeated.

QUESTION 649. *How are the brakes released?*

Answer. The rotary-valve handle 8, fig. 376, is turned back to the I position, or that "for releasing brakes," shown by figs. 371 and 375. This, as already described, allows air from the main reservoir to flow up through the pipe *X*, down through the port *a*, in the rotary-valve, into the cavity *b* in the valve-seat, and from there up into the cavity *c* in the under side of the valve, and thence down into the passage *l l* and to the brake-pipe *Y*. The pressure in the latter, as has been explained, acts on the triple-valve, which closes communication between the auxiliary reservoirs and brake-cylinders, and allows the air in the brake-cylinders to escape.

QUESTION 650. *In case of imminent danger or any emergency, how is the brake operated?*

Answer. In such an event it is, of course, essential to apply the brakes as quickly and as forcibly as possible. To do this the handle 8 of the rotary-valve is moved to the V or "emergency stop position," figs. 371 and 379. The chamber *c* in the under side of the rotary-valve then comes over the port *l* in the seat, which connects with the brake-pipe and also with the port *k*, which communicates with the atmosphere. This establishes direct communication between the train-pipe and the open air, and permits the air in the brake-pipe to escape quickly through the large openings of the ports referred to.

(TO BE CONTINUED.)

Manufactures.

Manufacturing Notes.

THE Dow Positive Piston Pump, which is now being introduced by the Kensington Engine Works, Philadelphia, is meeting with a very favorable reception and excellent reports are made of its performance. The first large one which was built—16 in.—has been in use at Elkton, Md., for two years past, giving much satisfaction; it is at work filling a reservoir and has required no attention but to keep the journals lubricated, and the Superintendent reports great economy in power. Recent sales include two pumps to the Remington Paper Mills, Watertown, N. Y., for high and low duty, including fire service, one of which is already in satisfactory use; a pump to supply a reservoir for Joseph Bancroft & Sons, Wilmington, Del., with 120 ft. lift, through 6-in. and 8-in. pipe; a pump for Callaghan Brothers' Cotton Mills, Philadelphia, with lift of 70 ft. through 600 ft. of 6-in. pipe; two pumps for the Quaker City Dye Works, one already in satisfactory use and the other with direct attachment to engine; also pumps for the Jessup & Moore Paper Company, the American Wood Paper Company, the Oneida Knitting Mills, and other parties. This pump was illustrated and described in the JOURNAL for December last.

THE Keystone Seal & Press Company, New York, has recently filled orders from a number of different roads for its car-lock and seal. These orders include one for a railroad in Guatemala.

THE Chicago, Milwaukee & St. Paul Railroad has had two of its through trains lighted with the electric light, the electricity being furnished by a dynamo in the baggage car ; incandescent burners are used. These trains run between Chicago and Omaha.

THE Transcontinental Car-Lock & Seal Company in Chicago, has elected John W. Norris, President and Treasurer ; Warren G. Purdy, Vice-President ; J. Edwards Fay, Secretary ; Charles E. Davis, Superintendent.

A PRETTY severe test of steam heating was recently experienced on the train known as the "Golden Gate Special," running between Omaha and San Francisco. During part of the trip the temperature was 32° below zero, and for a considerable distance west of Ogden 20° below. From this temperature the train, as it approached the western end of its trip ran into weather 60° above zero. The trainmen and passengers, however, report that the temperature of the cars was comfortable throughout the journey. This train is heated by the McElroy apparatus, manufactured in Detroit.

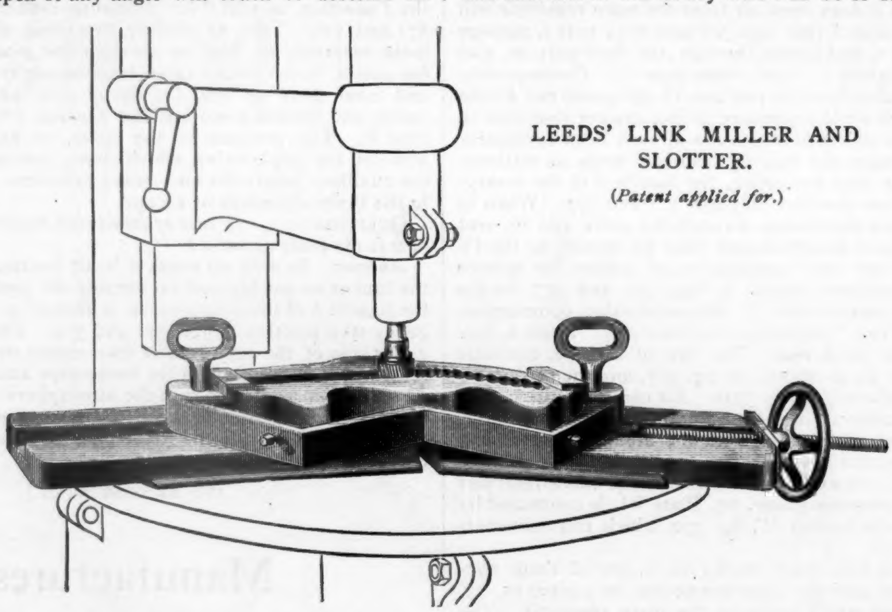
New Special Tools.

THE accompanying illustrations show two special tools recently introduced, which seem to be valuable additions to machine-shop plant.

The first is Leeds's link miller and slotter, which is intended to mill out links to any desired radius. It is designed on the principle that the apex of any angle will touch or describe all parts of a circle whose versed sine is equal to the perpendicular where the base is formed by the chord of the arc. It can be used on a good strong drill press, and will do excellent work. It can also be used as an attachment to a universal milling machine. It consists of a jointed frame having dove-tailed slots running lengthways to carry a frame that has the link blank secured in it, this frame is actuated by the screw and hand-wheel and describes a circle, according to the angular position of the lower or jointed frame ; flanges are cast on the bottom of this frame for the purpose of bolting down on the table or platen. In the center of the lower frame, at the center of the joint, is a bronze bushing that is set exactly under the center of the drill-press spindle ; this serves as a lower support for a boring bar and the shank of the milling-tool arbor. In practice it is found more convenient to drill a hole in one end of the link to be slotted, large enough for a boring bar to pass through, then by using a double-end cutter the slot is cut out to nearly the finished size ; the link is then moved along $\frac{3}{8}$ or $\frac{1}{2}$ in. and is cut through again until the stock is removed ; a milling cutter similar to a reamer is then used and the slot is finished to the radius for which the link is set. With this attachment a link 20 in. long is finished in about four hours. Directions for setting and operating are furnished for any particular case, and cutters or boring bars, milling cutters, arbors and mills made to order.

The second machine illustrated is Leeds's horizontal and radial drilling machine, which is designed to work on or from a drill press. It is mounted on the frame and is driven direct from the drill-press spindle. It is useful in drilling the ends and diagonal parts of locomotive frames ; it can also be mounted on the work and driven by a sliding shaft and universal joints. Drilling in all directions can be done with the two taper shanks and the horizontal and vertical movements, by loosening the nuts shown. This machine does away with the expensive ratchet worked by hand, and it is capable of drilling with as great speed as though drilled direct.

Both of these machines were invented by Mr. P. Leeds, Master Mechanic, Louisville & Nashville Railroad, and are manufactured by Pedrick & Ayer, Philadelphia.



LEEDS' LINK MILLER AND SLOTTER.

(Patent applied for.)

Electric Notes.

THE *Electrical Engineer* gives the following summary of the total number and mileage of street railroads operated by electric motors in this country :

	In operation.	Building.
Number of roads	58	33
Total mileage worked	308	220
Number of motor cars	424	287

This list includes several roads on which electricity has been only partially adopted, and on which horses are still in use for some of the cars.

IN the equipment of the electric railroad at Atlantic City, N. J., the trolley wire will be of the small size, no larger than an ordinary telephone or telegraph wire, which is used on all the Sprague roads, and which is characteristic of that system. The material of the trolley wire will be of silicon bronze, and its high tensile strength, over 80,000 lbs. per square inch, will enable the overhead system of supports to be of the lightest and most unobtrusive character possible. This trolley wire will be re-enforced by the regular system of a main conductor running parallel, according to the Sprague method, and tapped at necessary intervals along the line to insure a uniform pressure of electricity at all points of the road. This main conductor is also re-enforced by feeders running directly from the generating station, so that the size and weight of all the overhead work is reduced to a minimum.

Each car will be equipped with two 15 H.P. Sprague improved motors, flexibly suspended to insure against accidents from sudden strain in starting and stopping. The cars will be lighted by electricity, protected by improved lightning arresters, and will be of the finest construction and workmanship. Having a capacity of 30 H.P. upon each, they will be able, if necessary, to run at the rate of 15 miles per hour, drawing two loaded cars, and can handle any load which it is possible to put on them.

It is estimated that these electric cars will prove a great attraction to the many visitors at Atlantic City during the summer, and the most complete and expensive car equipments have been adopted in order to handle the large traffic. The first order for car equipments calls for 15 cars with overhead system and power station, but it is expected that this equipment will be increased before long.

The work on the overhead system for this railroad will be commenced as soon as possible, and it will not be long before

it is expected that the road will be in operation.—*The Electrician.*

The Westinghouse Friction Buffer.

A TRIAL of this buffer was recently made at the Pennsylvania Railroad car shops at Altoona, to determine the effect of the buffers when applied to freight cars, as well as the relative endurance of the buffers and the freight cars themselves. Two Pennsylvania Railroad gondola cars had been fitted with friction buffers for the purpose of this test. The cars were old and weak, and it was intended that the test should be so severe as to make them unfit for further service. The tests were conducted as follows: The two cars were set on a piece of straight track and the brakes on one firmly set; an engine hauled the other back and then gave it a shot down the track, so that it came into collision with the standing car. Fourteen such tests were made. In the first the moving car had a speed of about five miles per hour; in the successive tests, up to and including the eleventh, the speed was gradually increased, until, in the eleventh test, it reached 25 miles per hour. In the twelfth test, at a speed of 28 miles per hour, some of the blocking back of one of the buffers was smashed by the concussion, and one of the car trucks broke loose from its fastenings, and stripped the body bolster. This was due to the momentum of the heavy truck, and the sudden stoppage of the car body. On the fourteenth test, a speed of 30 miles per hour was reached, with the result that one center sill on the moving car was cracked near the body bolster, and both center sills of the fixed car were cracked at the same place; the drawhead of the fixed car was also broken in the shank; the bolsters under both cars were partially stripped from their positions. The buffers, however, remained intact and uninjured. The two cars were so badly used up as to be unfit for further service, while the buffers will be transferred to other cars and continued in service.

As has been heretofore noted, this buffer is manufactured by the Union Switch & Signal Company; its essential feature is, that friction is developed between interlocking sets of thin plates, and is brought into play as an aid to the regular draft springs in receiving and absorbing the momentum due to shocks which occur so frequently in the ordinary process of shifting and making up freight trains, and which are of daily occurrence on the road when trains are stopped and started, or are running over undulating grades.

Locomotives.

THE Schenectady, N. Y., Locomotive Works, have taken a contract to build six heavy locomotives for the Cleveland, Columbus, Cincinnati & Indianapolis Railroad.

THE Strong Locomotive, *A. G. Darwin*, the trial of which on the New York, Providence & Boston Railroad was recently noted, is now running on the Susquehanna Division of the New York, Lake Erie & Western Railroad between Susquehanna and Hornellsville. This is a particularly difficult section of the road and will give the engine a severe test.

THE Manchester, N. H., Locomotive Works have recently delivered two Mogul freight engines to the Boston & Maine Company, for use on the Central Massachusetts Division.

THE work on hand at the Rhode Island Locomotive Works, in Providence, includes 25 passenger locomotives with 18 × 24-in. cylinders for the Union Pacific; 10 passenger engines with 18 × 24-in. cylinders, and five Mogul passenger engines with 19 × 24-in. cylinders for the Chicago, Burlington & Quincy Railroad, besides several smaller orders for other roads. These Works have recently added to their smith shop three steam hammers made by Bement, Miles & Company in Philadelphia.

THE Boynton "Bicycle" locomotive, for a single-rail railroad, which has been built by the Portland Company in Portland, Me., was tried recently in that Company's yard, and is soon to be put at work on a short road, built by its inventor, Mr. Moody Boynton.

THE shops of the Pennsylvania Company in Fort Wayne, Ind., are building 10 consolidation engines, with Belpaire fireboxes.

Cars.

THE Pullman Car Company is building in its shops at Pullman, Ill., 200 coal cars for the Colorado Midland Railroad.

THE Buffalo Car Manufacturing Company is building 150 box cars for the Delaware & Hudson Canal Company, and 200 for the Cleveland, Columbus, Cincinnati & Indianapolis Railroad. The Company is building an addition to its wood-working shop and a new paint shop.

THE United States Rolling Stock Company has begun the manufacture of passenger cars in its Chicago shops; the first order is for 27 cars for a Southern road.

THE Lehigh Car Manufacturing Company at Stemton, Pa., recently shipped a number of ore cars to the Juragua mines in Cuba.

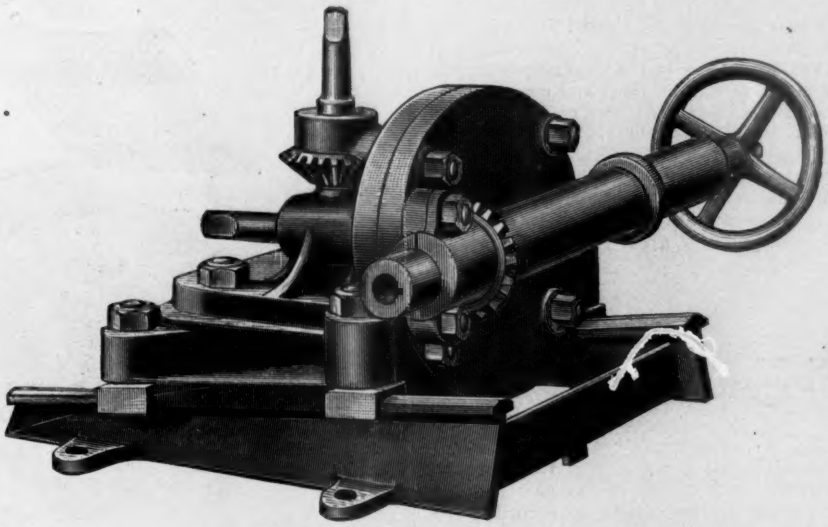
THE Fox Solid Press Steel Company has been organized for the purpose of building the Fox steel truck, and is erecting shops at Joliet, Ill., near the Works of the Joliet Steel Company. The officers of the new Company are: A. J. Leith, President; H. S. Smith, Vice-President; W. R. Stirling, Superintendent, and E. W. Hughes, Chief Engineer.

THE Springfield Car & Foundry Company has been organized to build car shops at Springfield, Mo. The new company will build a car-wheel foundry and freight-car shops in that place at once.

THE car shops of the Pennsylvania Company in Fort Wayne, Ind., are running on an order for 200 box cars, 130 for the Pittsburgh, Cincinnati & St. Louis, and 70 for the Pittsburgh, Fort Wayne & Chicago Road. These cars are to be of 60,000 lbs. capacity and are to be equipped with Westinghouse air brakes and Janney couplers. The Graham draft-rigging will be used in connection with the Janney coupler.

Marine Engineering.

THE Baltimore, Chesapeake & Richmond Steamship Company has contracted with Neafie & Levy in Philadelphia for an iron passenger boat, to run on the Chesapeake Bay line between Baltimore and West Point. This boat will be 240 ft. long, 38



LEEDS' DRILLING MACHINE.

(*Patent applied for.*)

ft. beam, and 24 ft. depth of hold, and will have triple-expansion engines, with cylinders 21 in., 34 in., and 55 in. diameter and 36 in. stroke.

THE Standard Oil Company has contracted with the Columbian Iron Works, Baltimore, for a tank steamer to carry 500,000 gallons of oil. This steamer will be 240 ft. long, 36 ft. beam and 23½ ft. deep, and will have triple-expansion engines with cylinders 19 in., 30 in., and 50 in. diameter and 36 in. stroke.

THE William Cramp & Sons Ship & Engine Company, in Philadelphia, are building a new steamer for the Morgan Line, after the designs of Mr. George B. Mallory, of New York. This vessel will be 350 ft. long over all, 42½ ft. beam, and 36½ ft. deep, and will have a carrying capacity of 3,000 tons of freight. She will have triple-expansion engines with cylinders 29 in., 45 in., and 74 in. diameter and 54 in. stroke, and will have four boilers 14 ft. diameter and 22 ft. long, carrying a working pressure of 160 lbs.

THE Harlan & Hollingsworth Company, in Wilmington, Del., have contracted to build a large transfer boat for the New England Terminal Company, to run between Jersey City and the Harlem River station in place of the old *Maryland*, which was recently destroyed by fire. This boat will be a side-wheel steamer 280 ft. long, 44 ft. beam and 17 ft. depth of hold, and will be driven by two independent compound engines, one to each wheel. Work on this boat is to be hurried as much as possible.

Pig Iron Production in 1888.

(From the *Bulletin* of the American Iron and Steel Association.)

THE total production of pig iron in the United States in 1888 was 7,269,628 net tons, or 6,490,739 gross tons, against 7,187,206 net tons, or 6,417,148 gross tons, in 1887. The production in 1888 was slightly in excess of that of 1887, and was the largest in our history. The extraordinary activity of the furnaces in the last few months of the year, notably in November and December, brought the total production far above the figures indicated by the statistical results of the first half of the year and by subsequent unofficial statements. While an increased production in the last half was anticipated, general surprise will be expressed upon learning how great it has been, which is shown as follows:

Production.	Gross tons.
First half of 1888	3,020,092
Second half of 1888	3,470,647

The total production of pig iron in this country since 1881 has been as follows, in gross tons:

Years.	Gross tons.	Years.	Gross tons.
1881	4,144,254	1885	4,044,526
1882	4,623,323	1886	5,683,329
1883	4,595,510	1887	6,417,148
1884	4,097,858	1888	6,490,739

Our production of pig iron in 1888, classified according to the fuel used, was as follows, compared with the production in 1885, 1886, and 1887:

Fuel—Net tons.	1885.	1886.	1887.	1888.
Bituminous	2,675,635	3,806,174	4,270,635	4,745,110
Anthracite	1,454,390	2,099,597	2,338,389	1,925,729
Charcoal	399,844	459,557	578,182	598,789

The anthracite figures include all pig iron made with mixed anthracite and coke, as well as that made with anthracite alone. The production of pig iron with anthracite alone is now annually less than that made with charcoal.

The production of pig iron in the Southern States in 1887 did not equal the general expectation, being only about 50,000 gross tons in excess of the production in 1886. But in 1888 the Southern pig-iron industry made a great stride forward. The production was as follows, compared with the production in 1885, 1886, and 1887:

States—Net tons.	1885.	1886.	1887.	1888.
Alabama	227,438	283,859	292,762	449,492
Tennessee	161,199	199,166	250,344	267,931
Virginia	163,782	156,250	175,715	197,396
West Virginia	69,007	98,618	82,311	95,259
Kentucky	37,553	54,844	41,907	56,790
Georgia	32,924	46,490	40,947	39,397
Maryland	17,299	30,502	37,427	17,606
Texas	1,843	3,250	4,383	6,587
North Carolina	1,790	2,200	3,640	2,400
Total	712,835	875,179	929,436	1,132,858

The increased production of pig iron in the Southern States in 1888 over 1887 was over 203,000 net tons. As late as 1865 the whole country made less pig iron than the South made in 1888.

Among the Northern and Western States which increased their production of pig iron in 1888 as compared with 1887 Pennsylvania is not to be counted; she made less in 1888 than in 1887. So did New York, New Jersey, Maryland, Wisconsin, and Missouri. Michigan's and Connecticut's figures for the two years do not materially vary. Illinois, Indiana, and Massachusetts show slight gains in 1888. Ohio shows a great gain, jumping from 975,539 net tons in 1887 to 1,103,818 net tons in 1888, and nearly equalling the production of the whole South.

Notwithstanding the large production of pig iron in the last few months of 1888, there was no increase of unsold stocks beyond the quantity on hand at the close of the first six months of the year; on the contrary, there was a decrease. The stocks of pig iron which were unsold in the hands of manufacturers or their agents at the close of 1888, *and which were not intended for the consumption of the manufacturers*, amounted to 336,161 net tons, against 401,266 net tons on June 30, 1888.

The Stearns Flexible Car-Axle Box.

THE accompanying illustration shows a car-axle box, manufactured and introduced by the American Railway Equipment Company of New York. The box is the same as the ordinary standard journal box, and in fact the device may be applied to any journal box of ordinary form. The arrangement consists of four steel balls, placed on top of the box and carrying a special cap upon which the equalizing lever of the truck rests. These steel balls are about 2 in. in diameter and are allowed to play in depressions about ½ in. deep in the top of the box, the cap

resting upon them having similar depressions. It is claimed that this device allows the journals to remain always in exact lines with their bearings, by providing for an oscillating movement between the box and the load and allowing a certain amount of radial movement on curves. Shocks are thus avoided and a very easy motion given to the car.

No change is required in the style of journal used, or in the interior of the box, and it can be used with any ordinary pedestal, so that it can be very easily applied to trucks now in use. This box is in use by the Wagner Palace Car Company and has been tried successfully on the New Jersey Central, the New York Central, the New York, Lake Erie & Western, the Delaware & Hudson Canal Company's lines, the Wabash Western, the Cincinnati, New Orleans & Texas Pacific, and other roads. The Wagner Company has a large number of its cars equipped with this box.

OBITUARY.

ALBERT M. SHAW, who died at his residence in Lebanon, N. H., January 31, was a well-known civil engineer for many years. He had been connected with the Boston & Providence, the Old Colony, and many other New England roads.

P. D. FISHER, who died in Indianapolis, Ind., January 28, had been connected as Assistant and Chief Engineer with the Columbus & Hocking Valley, the Kansas Pacific, the Toledo,

Delphos & Burlington, and many other Western roads. For some time past he had been Consulting Engineer of the Lake Erie & Western Railroad.

COLONEL FRANK S. PARROTT, who died in Bridgeport, Conn., January 29, aged 28 years, studied at Yale College, and some years ago became associated with his father and brother in the management of the extensive business of the Parrott Varnish Company. He was exceedingly popular, was active both socially and politically, and his death is regretted by many friends. He held a position on the staff of the Governor of Connecticut.

E. S. PHILBRICK died very suddenly while on his way from Boston to his home at Brookline, Mass., February 13. He was 65 years old and was widely known as a civil engineer of ability, having had charge of many important works, chiefly in New England. For some time past he had been Consulting Engineer of the Boston & Albany Railroad, and his services had been required as Consulting Engineer on railroad, bridge, and city works.

CORNELIUS H. DELAMATER, who died in New York, February 7, aged 67 years, was the founder of the great Delamater Iron Works in that City. He began work at 14 as clerk in a hardware store, and some years later was clerk in the old Phœnix Iron Works. In 1845 he undertook the management of those Works in partnership with Peter Hogg, and this firm continued until 1857, when Mr. Hogg retired, and the Works were afterward known under their present name. For a number of years Mr. Delamater was intimately associated with Captain John Ericsson, and many of his inventions were worked and constructed at the Delamater Works. During the war these Works did an immense amount of work for the Government, building the machinery of many war vessels; the original *Monitor* was also built and equipped there.

After the war Mr. Delamater retired from active work, but for a short time only. He resumed the management of the Works and continued actively engaged until his death. His son, who was associated with him for a number of years, will succeed him in charge.

SAMUEL MORSE FELTON, who died in Philadelphia, January 24, aged 79 years, was born in West-Newbury, Mass., graduated from Harvard College in 1834, and studied civil engineering. He was employed in the construction of railroads for a time, became Superintendent and Engineer of the Fitchburg Railroad in 1843, and left it in 1851 to become the President of the Philadelphia, Wilmington & Baltimore Railroad Company, which position he occupied until 1865, when he resigned, owing to ill health. He was soon after chosen President of the Pennsylvania Steel Company, the first company in this country to make the manufacture of Bessemer steel rails a commercial success, and retained that position until his death. He was a Commissioner of the Hoosac Tunnel in 1862, and a Government Commissioner of the Union and Central Pacific railroads in 1869. He was a member of the Centennial Board of Finance, and a director of the Northern Pacific Railroad Company from 1870 to 1873, and of the Pennsylvania Railroad Company from 1873 to 1883. He leaves a widow, four daughters, and three sons.

Mr. Felton will be chiefly remembered for his successful management of the Philadelphia, Wilmington & Baltimore Railroad during the war, when such a strain was thrown upon the resources of that line as no railroad in this country had ever experienced before. Entirely new conditions had to be met, new problems solved, and new demands satisfied with very little time for decision. Mr. Felton was equal to the position, and in it did work quite as valuable to the Government as that of many generals in the field.

PERSONALS.

M. BECKER has been appointed City Engineer of Austin, Minn.

A. J. PORTER is now Superintendent of the Kentucky & Indiana Bridge at Louisville.

JOHN C. HASKELL has been appointed Superintendent of Water-Works at Lynn, Mass.

CAPTAIN F. M. RAMSEY, U.S.N., has been ordered to the command of the Brooklyn Navy Yard.

W. MCWOOD now has charge of the Car Department on all the lines of the Grand Trunk Railway.

JOHN BROOKS has resigned his position as Superintendent of the Water-Works at Lansingburgh, N. Y.

J. K. LAPE has been appointed General Master Mechanic of the St. Joseph, St. Louis & Santa Fé Railroad.

C. K. DOMVILLE will hereafter have charge of the Grand Trunk Railway Company's foundries at Hamilton, Ontario.

HERBERT WALLIS now has charge of the Locomotive and Car Departments on all the lines of the Grand Trunk Railroad.

E. P. HENDERSON is now Master Mechanic of the Fort Worth & Denver City Railroad, with office at Fort Worth, Tex.

JOB ABBOTT, President of the Dominion Bridge Company, of Montreal, has opened an office at No. 150 Broadway, New York.

JOHN A. COLEMAN, the well-known engineer of Providence, R. I., has been elected Commissioner of Public Works of that City.

HON. WALTER L. BRAGG, of Alabama, has been reappointed a member of the Interstate Commerce Commission, for a new term of six years.

F. W. COOLBAUGH has been appointed Secretary of the American Live Stock Express Company, with office at 45 Broadway, New York.

JOHN B. HEIM, for seven years past Superintendent of Water-Works at Madison, Wis., has resigned that position to go into private business.

JOSEPH O. OSGOOD has resigned his position as Chief Engineer of the Lake Shore & Michigan Southern Railroad, which he has held for about a year.

THOMAS DOWNING has resigned his position as Master Mechanic of the Eastern Division of the Atchison, Topeka & Santa Fé Railroad.

CHARLES H. JONES, JR., has resigned his position as Secretary of the South Baltimore Car Works, to become General Manager of the Suffolk & Carolina Railroad.

W. M. HUGHES, recently Bridge Engineer in the office of the City Engineer of Cleveland, O., has been appointed Assistant General Manager of the Keystone Bridge Company, at Pittsburgh.

CLEM. HACKNEY, who recently resigned from the Union Pacific, has been appointed Superintendent of Motive Power of the Missouri Railroad, taking the place of Mr. O. A. Haynes, who has resigned.

C. L. GOULD, for some years past Chief Engineer of the Cleveland & Marietta Railroad, has resigned that position and has gone to Chili to take charge of the construction of some new railroads in that country.

J. P. WILLIAMS, J. L. GIBBS, and GENERAL GEORGE L. BECKER are the members of the new Railroad and Warehouse Commission of Minnesota. Messrs. Becker and Gibbs were members of the old commission.

JOHN S. LENTZ, Master Car-Builder of the Lehigh Valley Railroad, will hereafter have the title of Superintendent of the Car Department. He will have entire charge of the cars in the car shops of the Company, reporting to the Second Vice-President.

WILLIAM VOSS, Assistant Master Mechanic of the Burlington, Cedar Rapids & Northern, and author of articles on Railway Car Construction in the *National Car-Builder*, has accepted the position of Assistant Engineer of the Fox Solid Pressed Steel Company, with headquarters in Chicago.

WILLIAM GLYDE WILKINS, late Assistant Engineer of Construction on the Pennsylvania Railroad, and W. BLEDDYN POWELL, late Architect for the same road, have formed a partnership under the name of Wilkins & Powell, at 20 McCance Block, Pittsburgh, and 3125 Powelton Avenue, Philadelphia. They will practice as engineers and architects.

JACOB TOME, for many years a director in the Philadelphia, Wilmington & Baltimore Railroad Company, has given $2,500,000 to establish and endow a manual training school in Port Deposit, Md., his native town. It will be for the benefit, first, of children of that town, and, secondarily, for those from all parts of Maryland.

WILLIAM H. BURR, formerly on the Mexican National, has been appointed Chief Engineer of a French Company, which has undertaken to construct several railroad lines in Venezuela,

and sailed for that country early in February. He took with him as his Chief Assistant CHARLES CORNER, late Resident Engineer of the San Antonio & Aransas Pass Railroad.

PROCEEDINGS OF SOCIETIES.

American Society of Mechanical Engineers.—The Secretary gives preliminary notice of the 19th Convention, which is to be held in Erie, Pa., in the latter part of May. The exact date will not be fixed until the sailing day of the steamers, which are to take the visiting party to England, has been settled.

Members desiring to present papers at this meeting are requested to send in manuscripts and drawings before March 16.

The Secretary announces that the European trip will certainly be successful, enough members having signified their intention to join to justify the Society in chartering the steamer, and it is possible that a second steamer may be necessary. Members desiring to join the party are requested to notify the Secretary as soon as possible.

American Society of Civil Engineers.—At the regular meeting in New York, February 6, the Secretary announced the deaths of the following members: H. D. Blunden, Nathaniel W. Ellis, and Louis Lesage, and of Samuel M. Felton, a fellow of the Society; and the election to fellowship of James J. Hill, President St. Paul, Minneapolis & Manitoba Railroad, St. Paul, Minn.

A paper on Cost of Horse Power on Street Railroads in New York and Brooklyn, by G. Leverich, was read. This was followed by a paper on Improvement of Channels in Sedimentary Rivers, by George H. Henshaw.

A long discussion arose on the question of balloting on a renewed application for membership. The question was finally referred to the Board of Directors.

The following elections were announced by the Tellers:

Members: Samuel Lispenard Cooper, Yonkers, N. Y.; Sören Theodor Munch Bull Kielland, Buffalo, N. Y.; Samuel Clarence Thompson, New York City; Frank Herbert Todd, St. Cloud, Minn.; Schuyler Skaats Wheeler (Junior, 1887), New York City.

Associate: James Frederick Lewis, New York City.

Juniors: James Benton French, Philadelphia, Pa.; George King McCormick, Johnson City, Tenn.

IN place of the regular meeting of February 20 a joint meeting with the American Institute of Mining Engineers was held, at which papers on Iron and Steel were presented and discussed.

New England Water-Works Association.—A special meeting was held in Boston, February 13. In the morning the members visited the Chadwick Lead Works, where they witnessed the manufacture of lead pipes and other products.

At the business session in the afternoon a paper was read on the Quincy Dam, by L. A. Taylor. This was followed by papers on Effects of Erosion on the Pacific Coast, by S. M. Allis; Experience with a Sand Blast, J. L. Harrington, with another paper on the same subject by Phineas Ball; Painting Stand-Pipes, by J. E. Beals; Placing the Walking-beam in the *Puritan*, by W. M. Hawes; An Experience with Water Meters, by H. J. Holden. The meeting was very largely attended.

Boston Society of Civil Engineers.—At the regular meeting of January 16, Arthur G. Fogg, Henry M. Howe, Walter H. Richards, and W. S. Whiting were elected members. A letter from the Engineers' Club of Kansas City with reference to transfers of membership between local societies was referred to the Governing Committee. A Committee was appointed to arrange for the annual dinner in March.

A paper, by George H. Barrus, on Duty Trials of Pumping Engines, was read, and a short discussion followed.

Engineers' Society of Western Pennsylvania.—The ninth annual meeting was held in Pittsburgh, January 22. The reports of the officers showed that the Society was in good condition and that the attendance of the meeting had been large; the financial condition was also good. The President read an address reviewing the work of the past and giving suggestions for the future.

The following officers were elected: President, John Brashear; Vice-President, A. E. Hunt, Jr.; Directors, William Metcalf and M. J. Becker; Secretary, Colonel S. M. Wickersham; Treasurer, A. E Frost. Five new members were also elected.

After the close of the meeting a collation was served and a social meeting held.

The Secretary desires to say that engineers from other parts of the country who are visiting Pittsburgh are cordially invited to attend the meetings, or to call at any time at the rooms of the Society in the Penn Building.

Western Society of Engineers.—At the annual meeting in Chicago, January 8, the Secretary submitted amendments to the by-laws equalizing the dues of resident and non-resident members.

The retiring President, Mr. Gottlieb, made a brief address in regard to the work of the Society during the past year, and Vice-President Weston also made an address. The Secretary presented his annual report, showing a total of 191 members. The receipts for the year, $1,467, and the balance on hand, $164. The report noted the work done by the Committees, the papers read, and other proceedings of the Society, and urged that steps be taken to provide permanent quarters.

The following elections of officers were announced: President, E. L. Corthell; Vice-Presidents, Charles McRitchie and Samuel McElroy; Secretary, John W. Weston; Treasurer, H. W. Parkhurst; Librarian, G. A. M. Liljencrantz; Trustee, Charles Fitz-Simons.

The proceedings were closed by the annual supper, at which speeches were made, and which was attended by about 40 members.

Engineers' Club of St. Louis.—A regular meeting was held in St. Louis, January 16. A letter was received from the Engineers' Club of Kansas City in relation to transfer of members; this was discussed and then laid over to the next meeting.

A paper on Wrought-Iron and Steel Eye-bars, by Carl Gayler, was read, describing manner of making and testing them. It was briefly discussed.

A paper on a Burr Truss, by Professor A. E. Phillips, was read, describing a bridge near Lafayette, Ind. This called out a long discussion, in which mention was made of several wooden bridges which had been standing for from 40 to 50 years.

A committee was appointed to present a memorial to the Missouri Legislature in favor of the proposed Act for the safety of bridges.

A REGULAR meeting was held in St. Louis, February 6. Edward E. Wall, Henry Groneman and Nils Johnson were chosen members, and a number of applications were received.

The special committee on Bridge Reform Legislation reported progress and the memorial to the State Legislature was read.

Professor J. B. Johnson read a paper on Cable Conduit Yokes, their strength and design, giving the results of a number of tests made on different forms of yokes, and submitting a design for a new form composed of cast iron, strengthened by a steel tension member. This paper called out a discussion in which several members gave accounts of their experience with cable roads in St. Louis and elsewhere.

The question of transfer of membership was brought, discussed, and finally referred to the Executive Committee. The question of closer organization among the different engineering clubs was brought up and discussed at considerable length, and finally a committee, consisting of S. B. Russel, J. A. Seddon, and J. B. Johnson, was appointed, to devise a plan for a closer union among the different clubs.

Minneapolis Society of Civil Engineers.—At the regular meeting in Minneapolis, February 6, the papers read were on Solar Attachments, by W. R. Hoag, and on Subdivision of the Section, by G. W. Sublette. Both were discussed by members present.

Michigan Engineering Society.—A meeting was held at Lansing, Mich., January 23. The first paper was on Brick Street Pavements, by Professor C. E. Greene, of Ann Arbor, which gave qualities desirable for paving brick and detailed results of experience in a number of Western, Southern, and Eastern cities. The conclusion was that brick was superior to many other materials for ordinary street traffic, providing a proper selection was made. This paper called out a good deal of discussion, general opinion seeming to be somewhat against brick and in favor of asphalt.

Two sessions were held. Other papers read were on a New Method for Longitude, by H. C. Reassons; on Building Stones, by Professor W. H. Pettee; on a Special Agent's Trip in Nevada and Nebraska, by Isaac Teller; and on Water-Supply of Kalamazoo, by William B. Coates.

Northwestern Society of Civil Engineers and Architects.—This Society has been organized in Portland, Ore., with 20 members. The officers are: President, Captain Cleveland Rockwell; Vice-President, William Stokes; Secretary, R. A. Habersham; Treasurer, J. Krumbein; Librarian, H. G. Gradon.

Engineers' Club of Kansas City.—A regular meeting was held January 21. Henry Goldmark and Gerald Bourke were elected members. The Committee on Bridge Reform reported progress.

A paper on Electric Railroads, by A. N. Connett, was read, describing several of those now in operation.

A paper on Shrinking of Material and Settlement of Embankments, by a member, was read, giving experience in actual construction.

THE annual dinner of the Club was held January 28; there were present 33 members and several guests. Speeches were made and the affair was thoroughly enjoyed by those present.

A REGULAR meeting was held February 4. Roland Norris, A. J. Tollock, R. H. Bacot, and A. R. Meyer were elected members. O. Chanute, George H. Nettleton, and Charles F. Moss were elected honorary members.

A paper on Details of Iron Highway Bridges was read by E. W. Stern, describing ordinary practice, and speaking especially of the Schwedler truss. This was discussed by members present.

Illinois Society of Engineers and Surveyors.—The fourth annual meeting was held at Bloomington, Ill., January 23, 24, and 25, when a large number of papers were read, including an address from the President, C. G. Elliott, on Drainage of Large Tracts of Farming Land. Among the papers read were: The Cairo Bridge, by S. E. Balcom; Brick Construction in Engineering, by Professor I. O. Baker; the Metric System, by S. S. Greeley; Experience with a Culvert, by E. A. Hill; Sewage Disposal, by Professor A. N. Talbot; Springfield Water-Supply, by S. A. Bullard; Sources of Water-Supply and Their Development, by D. W. Mead; Mining Plant, by A. C. Brancher; a New Mexico Coal Mine, by G. W. Richards; Methods of Measuring Earth Work, by E. L. Morse; Municipal Engineering, by A. H. Bell; another paper on the same subject, by John W. Alvord; Section Subdivisions, by Henry C. Niles; Laws Relating to Division of Sections, by Z. A. Enos; Exterior Boundary of Townships, by F. Hodgman; Levee Construction, by E. J. Chamberlain; Electric Lighting for Small Cities, by J. H. Garrett; Railroad Accidents, by S. F. Balcom; Specifications, by W. D. Clark; Pavements, by G. W. Wightman; a Park Topographical Survey, by E. I. Cantine.

There were also discussions on a number of subjects of interest, including Systems of Track-work, Pavements and other matters. A large exhibit of drawings was made at the meeting. During its continuance the members visited the Chicago & Alton Shops, the City Water-Works, and other points of interest in the neighborhood.

The officers chosen for the ensuing year: President, C. G. Elliott, Gilman; Secretary and Treasurer, A. N. Talbot, Champaign.

Railroad Commissioners' Conference.—The following circular from the Interstate Commerce Commission was issued under date of January 31, and addressed to the State Railroad Commissioners:

"The State Railroad Commissions, with gratifying unanimity, have heartily approved the suggestion for a general meeting, and many who desire to attend have indicated the first week in March as the most convenient time;

"You are therefore invited to participate in a general conference of Railroad Commissioners, to be held at the office of the Interstate Commerce Commission, No. 1317 F Street, in the city of Washington, at 11 o'clock A.M., on the 5th day of March, 1889.

"Among the subjects which may be properly considered are the following:

"*Railway Statistics*, with especial reference to the formulation of a uniform system of reporting;

"*Classification of Freight*, its simplification and unification;

"*Railway Legislation*, how to obtain harmony in;

"*Railway Construction*, should regulation be provided?

"And such other topics affecting State and Interstate Commerce as may be brought forward by members of the Conference, the above suggestions not being designed to exclude the consideration of any other subjects of common interest.

"An opportunity will also be afforded for consultation in respect to the heating and lighting of cars, automatic car-coupling, continuous train-brakes, and other matters now more particularly within the sphere of State authority.

"Brief papers are invited from members of the Conference upon any topic deemed of importance. Arrangements will be made for preserving a permanent record of the proceedings."

Master Car-Builders' Association.—The following circular has been issued by the Secretary, from his office, 45 Broadway, New York City.

"At the last Annual Meeting of the Association, Lake George, Saratoga Springs, and Niagara Falls were selected as the three places from which a Committee were instructed to select one for the place of holding the next Convention. The Committee found that it was impossible to make satisfactory arrangements for hotel accommodations at either Lake George or Niagara Falls; and as none of the hotels at Saratoga will open as early as the second Tuesday in June—the regular time for holding the Convention—the Executive Committee authorized the postponement of the date of meeting to the fourth Tuesday of that month, which will be the 25th. The Annual Convention for 1889 will, therefore, be held at Saratoga Springs, beginning on that date at 10 A.M.

"All who attend the meeting will be entertained at Congress Hall, at a charge of $3 per day. One hundred and fifty rooms—the numbers of which have been specified—on the first and second floors, will be reserved for the members of the Association. Those who wish to engage rooms before the meeting, or to secure extra accommodations, should write to H. S. Clement, Manager, Congress Hall, Saratoga Springs, N. Y."

Franklin Institute.—The following is the programme of lectures to be delivered before the Institute during the month of March:

March 4: Unwholesome Trades and Occupations, Dr. H. A. Slocum.

March 11: Cable Telegraphy, Patrick B. Delany.

March 18: The Industries of Pennsylvania, Andrew Carnegie.

Association of North American Railroad Superintendents.—It will be remembered that at the last meeting of this Association the Committee on Roadway was authorized to offer a prize of $50 for the best essay on Track Work, the proper care of roadway and the most approved methods of building the superstructure of a railroad, accompanied by such estimates of cost as can be drawn by actual experience; also systematic track inspection and the plan of giving premiums.

Papers to be offered in competition for this prize should be sent to C. A. Hammond, Secretary, at 350 Atlantic Avenue, Boston, not later than April 10, 1889. Each paper should be signed with a motto or an assumed name, with directions for remailing to some railroad officer, giving correct address, to which manuscripts will be returned. The paper securing the prize will be retained for publication, and the writer's true name will then be obtained by the Committee.

Railroad Superintendents' Association of Memphis.—This Association has chosen the following officers for the ensuing year: President, J. H. Sullivan, Kansas City, Memphis & Birmingham; Vice-President, O. M. Dunn, Louisville & Nashville; Secretary, A. Gordon Jones, Little Rock & Memphis.

Central Railroad Club.—A meeting was held in Buffalo, N. Y., January 23. A number of members of the New England, New York and Western Club were present, by special invitation. A number of new members of the Club were elected.

The annual election resulted in the choice of the following officers: President, E. Chamberlain; Vice-President, A. C. Robson; Secretary and Treasurer, F. B. Griffith; Executive Committee, T. A. Bissell, E. Chamberlain, James Macbeth, Peter Smith, F. D. Adams, James R. Petrie, and Richard Donaby. President Chamberlain made a brief address.

A general discussion then followed on the Rules of Interchange, with special reference to the defects which would stop a car, and to Oil-boxes and Lids. Incidentally a good deal was said about Uniformity in parts of cars. Some suggestions for amendments to the rules were made.

After the meeting those present visited the Car-Wheel Works at East Buffalo and witnessed an exhibition of the Gould coupler in the East Buffalo yards. The meeting was closed by a dinner at the Tifft House.

New York Railroad Club.—At the regular meeting in New York, February 21, the subject was Heating and Lighting Passenger Cars. The meeting was opened by a paper on Steam Car Heating, showing the development and progress made, by E. E. Gold; this was followed by papers relating to different systems of heating.

A paper on Lighting Cars by Electricity was read by Dr. H. R. Waite. An exhibition was made on electric lighting, also an exhibition of the Pinch system of gas lighting.

Western Railway Club.—At the regular meeting, February 19. the subjects for discussion were:

Standard Axle for 60,000 lb. Cars; to be opened by a paper by Mr. Godfrey W. Rhodes.

Tender Trucks; to be opened by a paper by Mr. John Hickey.

Northwest Railroad Club.—At the regular meeting in St. Paul, February 5, the subject for the evening was Snow Plows and Flangers, continued from the preceding meeting.

Mr. W. T. Reed read a paper describing different kinds of flangers, and giving his experience with them, and recommending certain conditions to be complied with. Mr. M. Ellis and Mr. A. F. Priest also read papers giving their experience, and describing different devices in use. Mr. Ellis estimated the cost of running a flanger at $25 per 100 miles. The discussion was continued by Messrs. Ward, Lewis, Pattee, Barber, and others.

NOTES AND NEWS.

The Old Ironsides.—A miniature model of the *Old Ironsides*. the first locomotive built by Matthias W. Baldwin, in 1832, and the first locomotive to haul a train in the State of Pennsylvania, has been received by Mr. J. E. Watkins, Curator of Transportation and Engineering, from the Baldwin Locomotive Works, for the National Museum attached to the Smithsonian Institute. The workmanship, both internal and external, is a perfect reproduction of the original. The inscription states that as early as 1832 this locomotive attained a speed of 60 miles an hour.

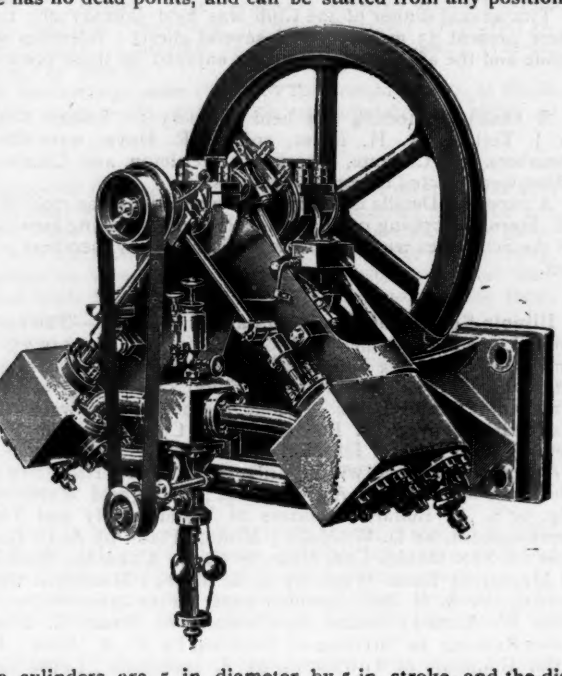
Italian Hospital Train.—A new hospital train has recently been built in Italy, which consists of six cars. Of these two are occupied by the surgeons, with their instruments and medicines; one by the kitchen and its attendants; one is used for provisions; one-half of the fifth is devoted to the "hospital administration," leaving only one-half of this car and the whole of the sixth for the accommodation of the wounded. The *Revue Scientifique*, in describing this train, makes this comment: "If this train is really intended for the service of the wounded, we must be permitted to find some disproportion between the space allotted to them and that taken up by the administrative service and the medical *personnel*."

Algerian Railroads.—In the French Colony of Algiers railroad building has been active for some time. An important line from Bougiah to Beni-Mansour was recently opened for traffic, and another main line from Blidah to Medeah is nearly completed. At the close of 1888 there were in operation 2,420 kilometers of railroad in the colony, owned by six companies, as follows: The East Algerian, 786; the Paris, Lyons & Mediterranean Company, 513; the Franco-Algerian, 434; the Bone-Guelma, 428; the West Algerian, 226, and the Mokta, 33 kilometers. The lines now under construction will bring this up to nearly 3,000 kilometers, or about one-tenth as much as the entire French mileage.

The Reading Elevated Line.—The amended plans for the new entrance into Philadelphia for the Philadelphia & Reading Railroad provides for the extension of the tracks from Ninth and Green streets to Twelfth and Market streets by an elevated structure, the entire removal of the tracks on Willow and Noble streets from Front Street to the west side of Broad Street, and on Ninth Street from Willow to Green, and the construction of elevated roads from Green Street to Glenwood Avenue on the Ninth Street Line, and from Front Street to Thirtieth on Willow and Noble streets and Pennsylvania Avenue.

The elevated structures on Willow and Noble streets from Front Street to Broad, are to contain two tracks, but those on Pennsylvania Avenue and from Market Street to Glenwood Avenue. are to have four tracks. The lines will be of solid masonry from Twelfth and Market streets to Ninth and Green, and from Huntingdon Street to Glenwood Avenue, and from Twenty-sixth Street to Poplar on the Pennsylvania Avenue branch. The remaining portions will be built on iron columns of handsome design. The bridges which cross the streets are to be ornamental structures, and the best modern appliances are to be used for deadening the sound of trains.

An English Wall Engine.—The accompanying illustration (from *Industries*) shows a small compact engine built to run a 25-ton overhead traveling crane at the electric light station, Deptford, England, by W. H. Allen & Company, of Lambeth. This engine, which may be called a diagonal wall engine, is intended to drive the cotton rope of the overhead traveler, and will itself be fixed against the wall overhead. The steam valve will be controlled by a lever, from which hang two ropes, so that the engine may be started and stopped from the ground level. The arrangement of cylinders being diagonal, the engine has no dead points, and can be started from any position.



The cylinders are 5 in. diameter by 5-in. stroke, and the distribution of steam is by means of piston valves. The engine has been designed for a boiler pressure of 120 lbs., and is governed by a Pickering governor to a speed of 250 revolutions per minute. The whole design is exceedingly neat, and the oiling arrangements are such as to insure perfect lubrication with a minimum of attendance.

A New Coast Channel.—Work has been begun on a new canal or channel which is to extend from Delaware Bay through Delaware, Maryland and Virginia, parallel with the coast, to Chincoteague Bay, a distance of about 75 miles. This channel is to have a width of 70 ft. and a depth of 6 ft. at low water. Very little actual excavation will be required, most of the work being dredging through the bays or sounds along the coast, and in streams and creeks connecting them.

The route is from Lewes, Del., up Lewes Creek, and by the series of ponds near the head of that stream to Rehoboth Bay. Thence it passes through Indian River, Little Assawoman Bay, Big Assawoman Bay, and Sinepuxent Bay into Chincoteague Bay, down which the channel will be continued to the inlet below Assateague Island. The work will be done by the United States, the State of Delaware giving the right-of-way where necessary.

The German Navy.—It may be said that previous to 1850 Germany had scarcely any naval force, and the present navy has sprung into existence since that time. Much of the efficiency of the navy is due to the thoroughness of the training of the seamen and the high attainments of the *personnel* of the service. The last annual report of the German Navy showed that there were on the active list 7 admirals, 719 officers of all grades, including engineers and surgeons, and nearly 15,000 men.

In the list of vessels are 13 iron-clad ships and 14 iron clad cruisers. In the class of unprotected vessels are 9 cruisers, 10 corvettes, and 5 light cruisers. In all there are 98 vessels, carrying 554 guns, and having a sum total of 182,618 tons displacement. There are at present 76 completed torpedo boats of the first class and 18 in course of construction, some of which are very small craft and suitable only for harbor use.

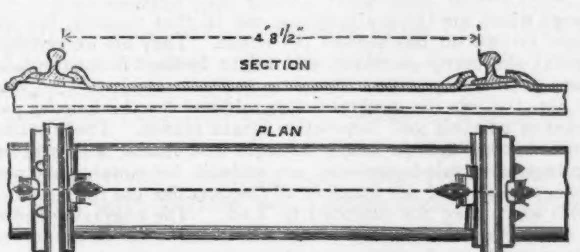
The most powerful vessel ever built for the German Navy was turned out from the Thames Iron Works, Blackwall, and called the *König Wilhelm*. In point of armor and heavy guns this vessel certainly has claim to the head of the German Navy List, but as to fighting qualities the opinions of foreign naval officers are on the whole adverse to the *König Wilhelm*. She is as clumsy as she is large, and though she is propelled by 8,300 H.P. and is a floating citadel in herself, the chances of a lighter and more manageable vessel against her are undoubtedly more favorable than one of her own kind.

Next to the *König Wilhelm*, in point of size and armament, are the sister battle ships *Deutschland* and *Kaiser*. Both of these vessels were constructed at Poplar, and were intended, in conjunction with the *König Wilhelm*, to form the nucleus of the iron-clad squadron of Germany. Sir Edward J. Reed was the designer of these vessels, and they are quicker and more easily manœuvered.

The most serviceable vessels that the Germans can count on are the four cruisers *Tieten*, *Blitz*, *Pfeil*, and *Hohenzollern*. These vessels are unprotected, though designed for offensive warfare. However, it may be stated that not a few foreign officers point to these four vessels as among the most efficient of modern cruisers.

The most recent addition to the navy is the *Greif*, a torpedo-chaser which is said to be the fastest war-vessel afloat.

An English Steel Tie.—In the improved steel sleeper of Messrs. Cabry & Kinch the jaws and studs are formed by hydraulic pressure entirely out of its own substance, as will be seen from the accompanying illustration. The tilt of the rail is obtained by pressing up, to the requisite angle, that portion of the sleeper only which is immediately under the base of the rail, instead of by the objectionable practice of bending the whole sleeper upward from the center. This enables the sleeper to be laid horizontally, and prevents its moving transversely in the ballast, thus obviating the necessity for closing the ends. The rail is placed in position by slightly tilting it, and passing one side of the flange under the inner or longer jaw, sufficient space being allowed for the outside of the flange to clear the shorter jaw, and then by sliding it under the shorter jaw, when the wedge-shaped steel split key is inserted under the longer jaw, and firmly driven. It will thus be seen that the flange is overlapped by both jaws of the sleeper, and that the rail cannot be forced out of them by the side pressure of the wheels of a passing train, even should the keys be displaced. The studs, against which the outside of the flange of the rail abuts, insure the permanency of the gauge of the railway, and



relieve the jaws of tearing strains. The cost at which this type of sleeper can be produced compares favorably with that of the ordinary chair and wood sleeper road, while its durability should be much greater, and a considerable saving in maintenance also be effected by its use. A considerable number of these sleepers has been laid down on the Central Division of the Northeastern Railway in the vicinity of Middlesborough, and they are also being laid upon the main line in the Northern and Southern divisions where the traffic is heaviest. The sleepers are made by Messrs. Bolckow, Vaughan & Company, Sheffield.—*The London Engineer*.

The Barranquilla Railroad.—The line of the Barranquilla Railroad & Pier Company in Colombia, South America, was formally opened for business on December 31 last. This line is short, but is commercially of great importance; it extends from Salgar to Puerto Colombia, giving the town of Barranquilla connection with deep water, and avoiding the tedious transfers and lighterage heretofore required to unload vessels. The railroad from Salgar station to Puerto Colombia is 3½ miles long; the pier at the latter place is 861 ft. long, having for 200 ft. at its outer end a width of 33 ft., with double tracks, a storehouse 170 ft. long, and unloading cranes. At the end of the pier there is 14 ft. of water at low tide, and the pier is 8 ft. above high-water level.

The company is now building two additional warehouses, each 130 × 30 ft. The equipment at present consists of a locomotive and 43 cars, and will soon be increased.

The work has been done under the supervision and according to the plans of Mr. F. J. Cisneros, an engineer well known in this country. Mr. Llewellyn Lloyd was Chief Engineer in immediate charge of construction.

The Rose Polytechnic Institute.—This Institute, at Terre Haute, Ind., is a school especially devoted to the education of civil, mechanical, and electrical engineers. It owes its existence to the generosity of the late Chauncey Rose, of Terre Haute, who bequeathed something more than $500,000 for its establishment and support. It is one of the youngest of the technological schools of the country, having been opened in the year 1883.

One of the peculiar features of the Institute is the thorough and extensive shop practice of the students in mechanical engineering. Not only are machines designed and working drawings made, but actual construction is required and is made possible in extensive workshops, the equipment of which has cost over $40,000, care having been taken to make it as complete as possible.

In electricity, in addition to the instruments and appliances usually found in electrical laboratories, it possesses the most complete and accurately adjusted series of Sir William Thomson's electrical balances in this country, and there is a completely equipped testing room for the purpose of calibrating and standardizing commercial instruments.

Another important feature is the restriction placed upon the number of students admitted. The plan of the Institute is to limit the attendance to such an extent as to realize the great benefits arising from small classes.

Shipbuilding in Scotland.—On the Clyde last year we find that the total number of vessels launched was 302, aggregating 278,970 tons, steamers making up 227,783 tons, and sailing ships 51,187 tons. In 1887 the total production was 326 vessels, aggregating 185,362 tons, including 203 steamers of 147,537 tons, and 123 sailing ships of 37,525 tons. When compared with 1886 and 1885, last year's total is found to show an increase of about 100,000 tons; but 1884 had a larger total to its credit by nearly 18,000 tons. In 1882 and 1883, however, the production was abnormally high, being 391,934 tons and 419,664 tons respectively. If the average for the last fifteen years is placed alongside the total for the year just closed, it will be found that the comparison is not unfavorable to the past twelve months, the average being 246,044 tons, and the aggregate for 1888 278,970 tons.

In the Forth the same briskness has characterized the year's work, as fifteen vessels aggregating 12,211 tons were launched, while in 1887 the tonnage was 5,897 tons, and in 1886, 7,967 tons.

The production on the Tay is not so great as it was in 1887, only eight vessels of 11,197 tons having been built at Dundee, while in the previous year fifteen vessels of 14,245 tons were built; but in the two years preceding that the figure was very much less. The work on hand, however, is very much greater, making up a total of eleven vessels of 16,079 tons. Not since 1882 has there been so good a prospect.

At Aberdeen there has been a marked improvement in the trade during the year, nine vessels of 6,640 tons having been constructed, as compared with six vessels of 1,822 tons in 1887, and there are now in course of building nine vessels of 9,110 tons, whereas at the beginning of last year there were only four vessels of 5,114 tons on the stocks.—*London Engineering*.

A Japanese Canal.—The Japanese Government has now under construction a canal, the principal object of which is to carry the water of Lake Biwa to the city of Kioto, to be used there for domestic purposes. The main canal, however, has been made of sufficient size to be used by boats, which will carry freight from the towns on the shore of the lake to Kioto. The main canal, which is about six miles long, leaves the lake at Otsu, and ends at a point on high ground adjoining the city and at a level of about 138 ft. above the plain upon which the town is built. It has a depth of 6 ft., and varies in width from 19 ft. to 28 ft. The entrance from the lake is through a lock, which was rendered necessary by the variation of the level of the water in the lake, which is as much as 10 ft. between a dry and a wet season. There are five tunnels on the main canal, the longest being about 8,000 ft. from end to end; the others are generally short. The section of these tunnels is 16 by 14

ft.; wherever necessary they are arched with brick. There is one short aqueduct on the canal, constructed of brick arches. From a point near the terminus of the main canal at Kioto a branch canal diverges and is carried down by a circuitous route to a junction with the old canal already existing in the city, which runs through its whole length and then connects with the Kamo-Gawa River. This branch canal is not intended to receive boats, but is merely a conduit for carrying water, and is only 8 ft. wide by 4½ ft. deep. The length of this branch canal is 4¾ miles, and there are on it two short tunnels, which are circular in form, 6 ft. in diameter. The total cost of this work, which is nearly completed, is $1,250,000, which appears low to us; but account must be taken of the extremely low price of labor in Japan. The work has been designed by a Japanese engineer, Mr. Yanabe, and is being executed under his direction.

New English Steamships.—The shipyards of Harland & Wolff, at Belfast, recently launched the first of two new steamers which they are building for the White Star Line, and which are named the *Teutonic* and the *Majestic*. These steamers will be the longest vessels afloat, and are built expressly for speed, being intended for passenger boats. Their dimensions are: Length, 582 ft.; beam, 57½ ft.; depth, 39½ ft.; gross tonnage, 10,000 tons. They are built of Siemens-Martin steel, and will each be propelled by two independent sets of triple-expansion engines, driving twin screws, with blades of manganese bronze. Their passenger capacity will be 300 first-class, 150 second-class, and 750 steerage passengers, and it is promised that the accommodations will be better than those on any steamers heretofore built. One feature of these vessels will be the hurricane deck, which will have a length of 245 ft., with a clear width of 18 ft. on each side of the deck-houses.

The Fairfield Shipbuilding Company at Govan, Scotland, recently launched a new steamer named the *München*, for the North German Lloyds. This ship is of steel throughout, is 405 ft. long, 46½ ft. beam, and 33 ft. deep. She will be driven by one set of triple-expansion engines, having cylinders 30 in., 50 in., and 80 in. diameter, with 54-in. stroke. Steam is supplied by two double-ended boilers 14½ ft. in diameter and 17½ ft. long, with 12 corrugated furnaces. The ship is provided with a complete electric plant, and incandescent lights are placed in every part of the vessel. A sister ship, named the *Dresden*, which was recently built at the same yard, although not designed as a high-speed ship, made 14 knots an hour on her trial trip, the engines developing 3,000 H.P. These ships will each carry 40 first-class, 20 second-class, and 2,000 steerage passengers.

Mining in China.—United States Consul Denby, of Pekin, China, reports that the silver mines, situated in the Jeho district, a distance of about 45 miles to the northwestward of Ping-Chuan-Chow, are worthy of being tested carefully. An examination made by John A. Church, a distinguished American mining engineer, shows that a yield of 20 taels per ton may be expected.

In November, 1887, Mr. Church arrived at the Ku-Shan-Tzu mines and commenced work there. He reports favorably of this mine and thinks that it will pay, and is satisfied that the yield will be from 20 to 30 tons a day. The formation in which the mines are situated is a hard grayish-white limestone, which is bounded on the south and east by granite.

The valley which is the approach to the mines contains a stream of water, which is utilized by the miners in the washing of galena from the waste, which was mined and thrown to one side in former years. In getting to the ore Mr. Church found about 200 ft. of water in the old shaft, but after a month's steady work he succeeded in reaching the bottom of the shaft, which was 320 ft. deep, and found a vein 5 ft. thick. Samples were carefully selected from the average ore and showed that a small vein about 2 in. thick yielded 90 ounces per ton. Copies of assays made by Professor Church show as high as 420 ounces of silver per 2,000 lbs. of ore, the average for 20 specimens from the Ku-Shan-Tzu ores being 231.5 ounces; the poorest specimen showing 102 ounces.

Chinese methods of mining, as might have been expected, are very crude, but when the American system of mining is introduced it will have an immense effect upon the development of the mining industry. Chinese officials are lending Mr. Church every assistance, and his operations are being conducted under the immediate auspices of the powerful Li Hung Chang, Viceroy of Chi-Li.

English Locomotive Cranes.—The accompanying illustrations (from *Iron*) show two cranes built by the firm of Appleby & Company, East Greenwich, England. These cranes show types which are in very common use in that country, but are little known on this side of the ocean. They are exceedingly useful for many purposes, and might be used in many places here to advantage.

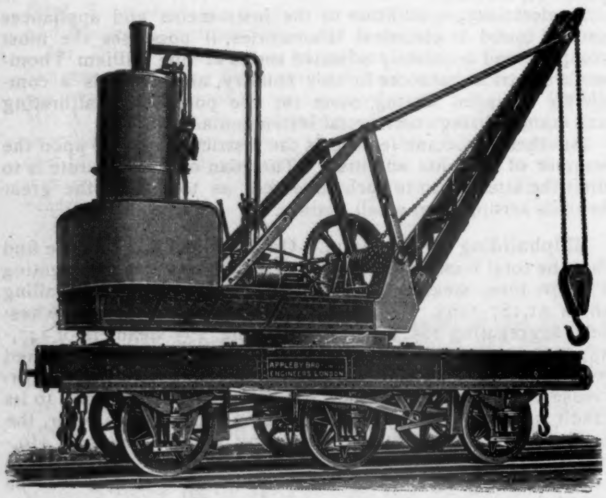


Fig. 1.

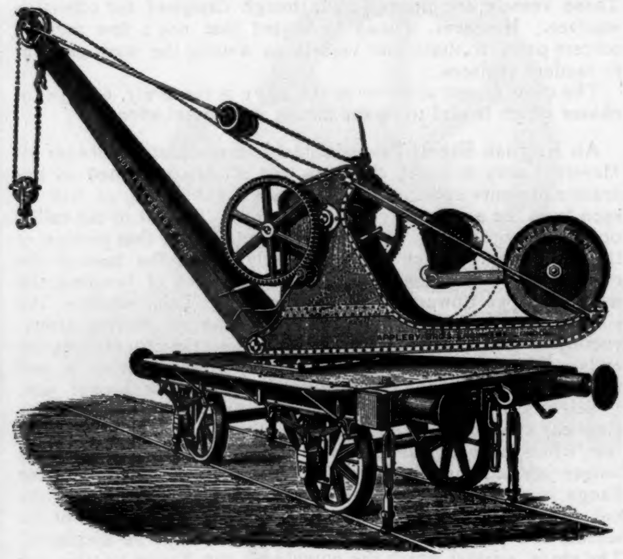


Fig. 2.

Fig. 1 shows the general design adopted by the heavier patterns of portable and locomotive steam cranes. These cranes are mounted upon a heavy wrought-iron frame, with wheels, springs, and axle-boxes, and are suitable for running on permanent way, and are fitted in all respects like the rolling-stock with which they are intended to work. The engraving shows a fixed jib, but they are sometimes fitted with an improved chain-and-lever derricking gear by which the jib is held and moved with the least possible strain on the framing.

Another type of cranes is that shown in fig. 2, which represents a portable hand-crane suitable for railroad permanent-way work, and fitted with a self-acting balance. In this arrangement the tie-rods, instead of making direct attachment to the side frames, have fitted to their lower ends chain sheaves, each carrying a chain. One end of each chain is attached to a chain barrel fitted with worm and wheel gear, while the other ends are coupled to the short arms of two bell-crank levers having a fulcrum on the top of the side frames. The lower ends of the long limbs of the bell-crank levers are fitted with weights, connected by wrought-iron links to the axis of a cylindrical balance-weight, which is free to roll on the tail-piece of the crane framing. When the load is being lifted, the strain due to the weight of the load passes through the tie-bars and chain to the short arms of the bell-crank levers, and the strain thus applied causes the long arms and weights to rise out of the vertical position and to move the cylindrical weights into the position shown, or until they are at a distance from the center sufficient to counterbalance the load being lifted. When the load is released, the levers assume the position shown by the dotted lines.